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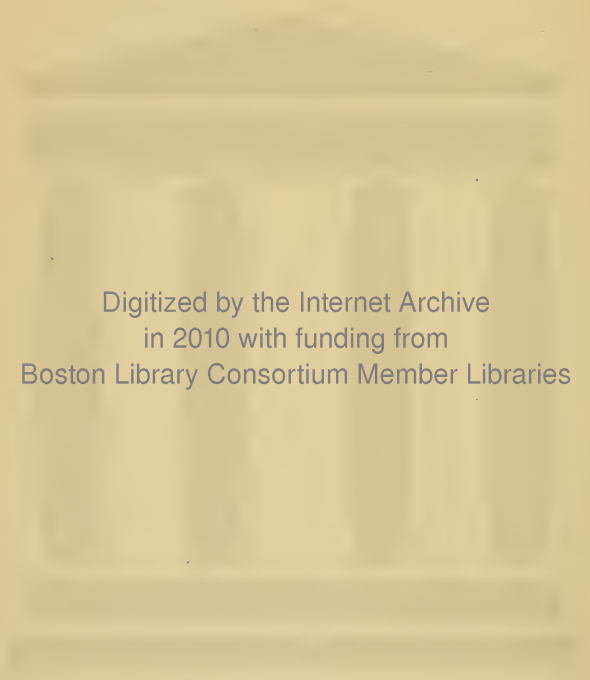


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DRAW FRAMES

AND

FLY FRAMES.



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DRAW FRAMES

AND

FLY FRAMES

BEING A

Practical Treatise on the above Machines,

BY

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PREFACE.

March 1967

IN design and treatment this book is essentially a companion volume to the Author's previous treatise upon Self-acting Mules. While it is hoped that the subject matter will be of interest and profit to students generally, it is more especially intended to benefit those who are directly concerned in the practical working of the machines under discussion, whether as overlookers, fitters, managers, masters, or in other capacity. Other writers have treated fully and ably of the purely descriptive and mechanical side of the subject, and, therefore, although such treatment is by no means herein omitted, yet attention has been more particularly directed to such points as are concerned, more or less, in obtaining the best results from the machines in their actual manipulation. The Author's greatest aim has been to make the book of practical utility to persons actually in the trade.

Thanks are due to those firms who have kindly assisted in the matter of the illustrations, and to one or two gentlemen who have assisted in other ways.

It must be distinctly understood that a great proportion of the drawings are simple lecture diagrams, which can be readily comprehended and copied by teachers or students for class purposes.

THOMAS THORNLEY,

Bolton, 1898.

CONTENTS.

	PAGE.
CHAPTER I.	
Drawing and Preparation Frames 70 Years Ago ...	I
CHAPTER II.	
Drawing Frames	14
CHAPTER III.	
Fly Frames, Elementary Description of ...	53
CHAPTER IV.	
Fly Frames--Winding Problems and Connections ...	67
CHAPTER V.	
Fly Frames—Building Motion	116
CHAPTER VI.	
Fly Frames—Changing from Twist Way to Weft Way, &c.	167
CHAPTER VII.	
Fly Frames—How to Put Up	195
CHAPTER VIII.	
Fly Frames—New Differential Motions... ..	219
CHAPTER IX.	
Roller Setting and Roller Drawing	257
CHAPTER X.	
Defective Roving Bobbins	285
CHAPTER XI.	
Calculations on Draw Frames and Fly Frames ...	347

CHAPTER I.

DRAWING AND PREPARATION FRAMES SEVENTY YEARS AGO.

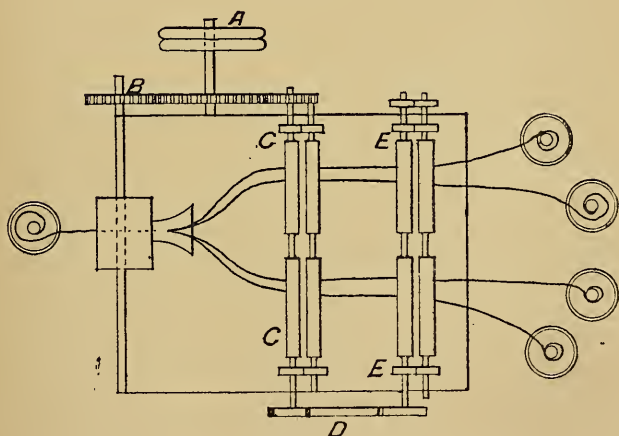


FIG. 1.

In Fig. 1 is given the plan of a type of drawing frame which about 1830 had been in use a good number of years. At **A** are shown the fast and loose pulleys. From **A** the wheels **B** gave motion to the delivery roller. The machine contained four pairs of drawing rollers, as is yet the practice. It contained, however, two roller beams, with two pairs of drawing rollers to each beam. The front rollers **C** were driven directly from **A**, and then at **D**, on the other side of the machine, are shown the wheels by which the rollers on the back beam **E** were driven from the

front beam. The exact connection of the wheels and their relative sizes is not shown in this sketch. As shown in the figure, four slivers were united into one. The total draft was generally sufficient to bring the front sliver out a trifle finer than the back sliver, more draft being put in the front rollers **C** than between the back rollers **E**. Between the two beams a space was often left of 6 or 7 inches, and care had to be exercised to have little or draft at this point, otherwise much fibre would have fallen out. The rollers are shown with double bosses, each 6 or 7 inches long, which was an improvement on a previous form, which had four bosses, or one boss to an end, and was considered to give uneven drawing.

It may be remarked that just prior to 1830 drawing frames having the present system of only one roller beam to contain the four pairs of drawing rollers had been successfully introduced in a number of mills. The chief advantage over the two-beam system was that three intermediate drafts were obtained instead of only two. The chief objection raised to the new method was that the draft wheels were all set close to each other, leaving little space for making changes, an objection which has not altogether been obviated even yet. The principles of doubling and making the fibres parallel were recognised then, as now, to be the objects of the machine.

To those who have studied the subject of weighting draw-frame rollers, the following note, given exactly as written nearly 70 years ago, will doubtless be of interest:—
 “It has often been disputed whether the drawing frame should be fitted up with dead or lever weights. Upon this subject a considerable diversity of opinion exists among managers. The dead weight is doubtless the most solid and uniform, as it acts always the same, whereas the lever acts with a kind of vibrating motion, caused by the shaking and agitation of the machinery, together with the inequalities in the body of cotton that passes between the

rollers. Dead weight is only adapted for fine light cotton, for when there is a heavy body of cotton that is long and strong in the fibre passing the frame, it requires a very great load of dead weight suspended from the rollers to make it draw equally, whereas the other, by shifting the weight upon the lever, can be adjusted to suit either heavy or light cotton, and therefore is preferable to the dead weight. But perhaps it might be an improvement to have draw frames adapted to both, that they might be changed when found necessary."

PREPARATION FRAMES.

The time we are referring to was identified with the successful introduction of Houldsworth's differential motion, at which time preparation frames were in a very unsatisfactory and unsettled state. Various styles of machines were used for the preparation of roving for the spinning machines, and a brief description of some of them cannot fail to be interesting.

CAN FRAME.

The can frame of Arkwright was still in use in various mills. It generally contained four pairs of rollers, with the two back pairs a little separated from the front pairs, similar to the draw frame, and having a total draft of from 10 to 14. From the rollers the cotton was delivered into a revolving can, made in the form of a truncated cone. On the top of the can there was a small funnel, through which the roving passed, while the revolving of the can gave it a small amount of twist, which could be varied by the speed at which the can was made to revolve. By its centrifugal motion the roving was coiled round within the can until the latter was full, when it was taken out and wound on bobbins at a winding block or machine, driven

either by hand or power. The cans were supported at the bottom on pivots, and to give them a steady revolution the funnel at the top was guided by a collar attached to the framing. A pulley was fixed to the bottom of the can, by which it was driven by a band from a cylinder shaft extending the whole length of the frame. Each can had a door upon one side for taking out the roving, and a ring clipped the can to keep the door shut until the can was full. The rovings prepared in can frames had to be wound on bobbins by a separate process, which was expensive and injurious to the cotton. In spite of these drawbacks it was very popular for many years.

THE SKELETON FRAME.

This was a machine designed to displace the can frame and to prevent injury to the rovings by winding on bobbins. It consisted of a revolving frame—called the skeleton—with a top and bottom similar to the revolving cans. A can was placed within this frame, and when full of rovings it was taken out and carried direct to the back of a stretching frame, where the rovings were further reduced and prepared for the jenny. An exceedingly good rove was obtained by this process, but it was so slow that it never got much hold in the trade.

JACK FRAME.

A machine called the jack frame, or jack-in-the-box, was long used to a limited extent, and both prepared the rovings and wound them on bobbins at the same time. It was an ingenious, but complicated and slow machine. It had a revolving frame, within which a small cylinder moved vertically, the surface speed of which was equal to the surface speed of the front rollers. The bobbin, resting upon the cylinder, was moved by frictional contact there-

with, and took up the roving at the same rate as it was delivered by the rollers. Simultaneously, twist was put into the roving by the horizontal rotatory motion of the jack, and was also built uniformly on the bobbin by means of a guide wire. This machine did not appear to receive as wide an adoption as the can frame, but more closely resembled the machines now used. Its name was retained in the later machines.

TUBE FRAME.

This machine was introduced almost concurrently with Holdsworth's differential motion, and for a time received considerable favour. Dyer's patent tube frame was in use thirty years later, but finally had to give way to the improved fly frame. The tube frame, instead of revolving cans as in Arkwright's can frame, had revolving horizontal cylinders parallel with the drawing rollers, and placed about 12 inches in front for single frames, but double tube frames had one cylinder about 10 inches from the beam, and a second cylinder about 20 inches away. The circumferential speed of these rollers was about equal to that of the front roller. The bobbins, resting on the cylinders (somewhat after the style of the warp resting on the wooden drum in a beam warping machine), were revolved by frictional contact at a uniform surface speed. A small hollow cast-iron tube, about $4\frac{1}{2}$ inches in length, was fitted up in front of the bobbin, through which the roving was conducted until about one inch from the point where it was brought out by a small opening, and carried over what was called the bridge of the tube, when it again entered, and was brought out by a hole at the point called the eye. While the roving was passing through the tube was made to revolve at about 8,000 revolutions per minute, and by being brought over the bridge, it was taken hold of by the tube and twisted considerably between the tube and the

rollers, but all the twist was taken out again between the bridge of the tube and the bobbin. The tube frame was remarkable for the great amount of its production, but its inability of twisting the roving was a serious drawback to its success.

STRETCHING FRAME.

The use of the stretching frame was to reduce the grist of the roving so as to prepare it for the jenny, but about seventy years ago its use was rapidly diminishing, as most managers preferred the finishing fly frame for that purpose. In this machine the attenuation of the cotton was accomplished by drawing rollers, and a carriage was used to recede from the rollers and take the rovings whilst twist was being imparted to the latter, afterwards winding was performed. A pulley called the "Mendoza pulley" was used for drawing the carriage out.

FLY FRAMES.

These were for a considerable time rivals with the can-frame and other machines for dealing with the cotton between the draw frame and the spinning machine. About 70 years ago, in one style or another, the fly-frame had just asserted its superiority in principle over the other machines, and had become somewhat largely adopted, and at this time it received a great impetus from the adoption of Holdsworth's differential motion. In every instance there was a bobbin and a flyer revolving round a common centre, and the winding was accomplished by one of the two having a surface speed in excess of the surface speed of the other equal to the surface speed of the front roller. From the very first it was a question as to whether the bobbin or flyer should lead, and some men chose one way, whereas others chose the other. This fact has peculiar interest to the minds of practical men,

simply because it is now, as it was then, a somewhat controversial point as to which is the better when all things are considered. Now, however, most individuals regard bobbin-leading the better, whereas at that time the flyer-leading system soon established itself as the favourite. Very great differences of construction, however, at that time existed in the various contrivances which were devised for accommodating the winding to the ever-increasing diameter of the bobbin.

UNEQUAL RACK.

The lecture diagram in Fig. 2 indicates one arrangement which at that time was in considerable favour. There was only one cone, and this was arranged on the main shaft of the frame in such a manner that it could both receive a rotary motion therefrom and could also be slid longitudinally on the shaft, as the bobbins increased in size.

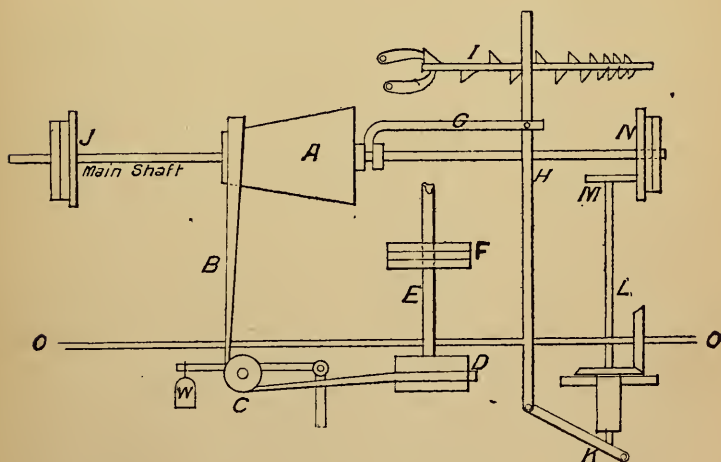


FIG. 2

From this uniform cone **A**, motion was conveyed by the belt **B** passing round the guide pulley **C** to the pulley **D** on the vertical shaft **E**. On this shaft was the bobbin pulley **F**, round which passed a cord, which was then conducted round all the wharves or pulleys upon which the bobbins rested. It will be noted that there were no bobbin or spindle bevels on this machine, although about this time such bevels had begun to be applied to these frames. The cone was connected by the rod **G** to the traverse lever **H**, the latter being connected to the unequally divided rack **I**. The rack **I** shifted one tooth at every reversal of the bobbin rail in the direction of the cone, the latter being compelled also to move in the same direction by the connections just indicated. The thick end of the cone was thus gradually pushed under the cone belt, thus giving the necessary increase of speed to the bobbins, allowing that the frame had the flyer to lead. The cone drum was neither concave nor convex, but to bring about the same result as is achieved now by such drums, the cone rack was unequally divided, so that the cone was longitudinally slid a much greater comparative distance for the addition of a layer to the empty bobbin than for the addition of a layer to the full bobbin, all the movements being graduated in extent between these two extremes. To make this point clear. Suppose there is correct winding during the first layer of roving put on the bobbins, and the bobbins be increased in diameter $\frac{1}{8}$ th inch, and moreover this $\frac{1}{8}$ th inch equals $\frac{1}{10}$ th part of the total diameter, then the cone must be slid so as to have the belt working on a diameter of the cone which has been increased by $\frac{1}{10}$ th part of the total. Again, suppose for the full bobbin the winding be correct, and we then increase the diameter of bobbins by $\frac{1}{8}$ th inch, and this $\frac{1}{8}$ th inch only equals $\frac{1}{30}$ th part of the total diameter, then the diameter of the cone must only be increased by $\frac{1}{30}$ th part of its total diameter. This unequal movement of the cone, in order

to accommodate the winding to the increasing diameter of the bobbin, was accomplished by dividing the rack unequally according to the principle of calculation just indicated. The rack was designed to contain as many teeth as there were layers of rove likely to be put on the bobbins, therefore a rack with 25 teeth would allow 25 layers to be put on the bobbins. Special mechanism was designed to perform the accurate cutting of the rack.

Referring again to the lecture diagram, the spindles were driven by a cord from the pulley **J** being conducted round all the spindle wharves. The differential driving of the lifter rail was, in this machine, as now controlled from the rack. The traverse lever **H**, as already explained, was connected to the rack at the top, while at the point **K** it supported the vertical shaft **L**, on the top of which was the friction pulley **M**, which had no teeth, but was covered with leather or cording, and, bearing against the face of the friction plate **N**, was moved by contact therewith, and at the same time was connected to the shaft **O** by wheel-gearing as shown. On the end of this shaft was a small pinion driving a mangle wheel, which was fixed on a shaft controlling the vertical movement of the lifter rail. It is well-known that the mangle wheel is a mechanical contrivance for converting rotary into reciprocating motion. As the bobbins increased in diameter the friction pulley **M** was made to approach the centre of the friction plate **N**, by its connection with the rack by the traverse rod **H**. The speed of the vertical traverse of the bobbins was thus decreased in proportion to the increase in diameter of the bobbins. The cone belt was kept tight on the cone by the weight **W** hung on the end of a lever.

VARIOUS ITEMS.

Somewhere about the time of Holdsworth's motion being invented, viz., 1826, the cords and pulleys used for driving the spindles and bobbins were displaced by the

successful introduction of shafts and toothed wheels for the same purpose, which gave more uniform winding and twisting of the roving. In some machines at that period the method was adopted of having two cones for driving the bobbin and the lifter in a differential ratio, but the single cone system appears to have been much more popular. In other frames only one cone was used, but instead of having an unequally divided rack, the cone drum was constructed so that equal portions of traverse of the cone belt gave unequal variations in the revolutions of the bobbins, but equal variations in the circumferential speed of the bobbins. This was exactly on the principle that the lower cone is now constructed, with the difference that now the variation in diameter is divided between the upper and lower cones. The sun and planet motion introduced about this time may be described as follows:—Two pulleys—one for driving the spindles, called the twist pulley, and the other for driving the bobbins—were placed on the frame shaft, the twist pulley being made fast and the bobbin pulley being loose on the shaft. They were placed near to one another, but instead of coming into contact, a spur wheel of the same diameter as the pulleys (about 10 inches) was introduced between them. This was the sun wheel, and contained a carrier wheel in its spokes. This carrier, bevel geared with a bevel secured on the inside of the twist pulley on one side, and with another bevel in the bobbin pulley on the other side. The twist pulley, revolving with the shaft, imparted motion to the bobbins, which motion was varied by the revolution of the sun wheel, as at present. This variable motion of the sun wheel was imparted by a single cone drum. Arkwright's fly frame was early tried at making rovings, but, as might be expected, it was a failure, as the weak nature of the cotton at this stage rendered it utterly incapable of pulling the bobbin round. His attempts to drive the bobbins at a differential speed were also unsuccessful.

RAILWAY DRAW FRAME.

This was a term given to a kind of frame that was somewhat used in the fifties. It contained two heads or sets of drawing rollers, set at right angles to each other. The slivers after passing through the ordinary drawing rollers, were given a half turn round guiders, and, being united together, were passed through the second rollers. In appearance and action the machine was something similar to the ribbon lappers now used in fine spinning. The lecture diagram Fig. 3 is intended to show the principle of the machine and nothing more. At **A** are the back cans, 32 in number, and eight of these back slivers being united

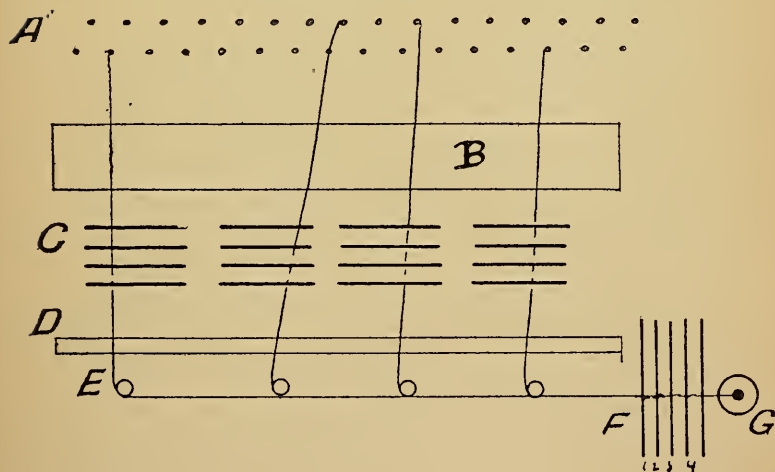


FIG. 3.

into one front sliver, passed over the guide plate **B** and through the usual drawing rollers at **C**. They then passed through the conducting roller **D**, half round the guiders at **E**, and the 32 were then united in one sliver and

passed through the rollers of finishing head at **F** into the front can. It will be noticed that $8 \times 4 = 32$ doublings are here obtained in a cheap manner. What was probably the chief defect of the system may now, however, be pointed out. If the front roller in the first drawing head at **C** made 200 revolutions per minute, then the back roller of the finishing head at **F** would have to make the same number to keep the slivers tight enough. Therefore if the finished sliver was required from the finishing head as light as it was put up at **A**, the front roller of finishing head would have to make 800 revolutions per minute. Flat waste and lap-licking were thus developed to a most detrimental amount. Mr. Evan Leigh contended that "in this arrangement the slivers went straight through the machine without being drawn the reverse way, as is the case with the ordinary draw frame; and a valuable principle had been condemned because of defects which could have been overcome by improvements in the rollers." The railway drawing frame was a special development of the railway heads applied to some carding engines in America, and formerly to a limited extent in this country.

TATHAM AND CHEETHAM'S CAN SLUBBING FRAME.

The imperfections of the early bobbin and fly frames, as we have previously remarked, led to the invention of many substitutes of greater or less merit.

Shortly after the invention of the coiler, the above inventors applied the latter principle to the slubbing frame. Ordinary coiler cans, but only about six inches diameter, were used instead of spindles and bobbins, and back and front stop-motions were applied. The advantages claimed were chiefly the quicker front roller speed, combined with the rejection of all the complicated building and winding mechanism necessary in the fly frame. The absence of twist in the slubbing, combined with

improvements in the fly frames, led to the somewhat early abandonment of the use of these frames.

THE ABEGG ROVING FRAME.

This was invented by a Swiss gentleman of that name, and consisted of a very ingenious contrivance for building slubbings or rovings on concentric rings round a vertical rod, fixed on a disc of wood, thus dispensing with cotton cans, as these discs could be carried about and set behind other frames, after which the rod was withdrawn. This invention never obtained a footing in England, but had considerable adoption amongst the Swiss spinners.

THE ECLIPSE ROVING FRAME.

This was another clever machine for producing a large quantity of untwisted rovings, using straps running in opposite directions, between which the cotton passed, being thereby twisted and untwisted as the straps rubbed together. It was never equal to Dyer's frame.

CHAPTER II.

DRAWING FRAMES.

INTRODUCTION.

This machine is one of the simplest in the whole series employed in the processes of cotton spinning. In one respect it may be regarded almost as an encumbrance, inasmuch as we do not advance one step in this machine in the work of reducing the cotton to a thinner or finer character. The carding engine, which immediately precedes the draw frame, attenuates the material by a draft of a little more or less than 100, as the case may be, in addition to performing its other and vastly important objects. Although it would be almost impossible to secure a good yarn without the draw frame, it practically leaves the sliver the same weight per yard for the slubber as it was upon leaving the card. This is chiefly because several slivers are doubled together at the draw frame, and the draft in the rollers is employed in neutralising the thickening effect of the doubling. By far the most common practice is to double six ends together, but any number from four to eight may be doubled together, the lesser amount of doubling being for coarse yarns and the greater amount of doubling being for fine yarns. The machine derives its name because its distinctive feature is the employment of four pairs of rollers, revolving at different rates of speed, so as to "draw out," or attenuate, the cotton in its passage through them. Each pair of drawing rollers the cotton comes to revolve at a quicker rate than the pair immediately preceding them, in a gradually increasing ratio. Fig. 4 (see Plate I) gives a general view of the machine as

made by Messrs. Brooks & Doxey. It will be as well if we first trace the simple passage of the cotton through the machine.

PROGRESS OF MATERIAL.

The lecture diagram Fig. 5, indicates the passage of the cotton through the machine. Each sliver is taken from the card can at **A** and passed through a hole on the guide plate **B**, of sufficient size to allow of the sliver easily passing through in a straight condition, but not lumps or knots of sliver. The latter must become disentangled before

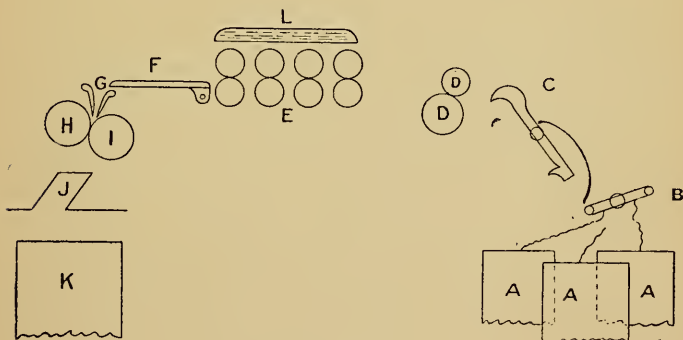


FIG. 5.

passing through the guide hole. The sliver next passes over the spoon **C**, which is part of the automatic stop-motion, and then between the single preventor rollers **D**, and between the four pairs of drawing rollers **E**, over the top of the polished plate **F**, through the funnel **G**, between the two calendar rollers **H**, **I**, down the oblique shaped hole **J** into the front can **K**. **L** indicates the flannel-faced flats, or cleaners, for licking the loose fly, etc., from the leather rollers. **M**, **N**, **O** indicate the wheels by which

motion is transmitted from the small wheel on back roller to the small wheel on the bottom single preventor roller. The reader is referred to the chapter on calculations for detailed diagrams which show the whole of the gearing and manner of driving the various parts of the machine.

OBJECTS OF DRAWING FRAME.

The drawing frame performs two vastly important and necessary functions, each of which is performed with the direct and definite object of producing a stronger finished thread of yarn than would otherwise be possible. It does not specially aim at twisting, or cleaning, or opening, or attenuating the cotton. (a) It makes the fibres parallel to each other by the "drawing" action of the rollers. (b) It makes a finished sliver of a much more even and regular character than the sliver from the carding engine. Incidentally, it takes out a portion of small sand, leaf, etc., which falls out when the material is opened out as it passes through the drawing rollers.

PARALLELISATION OF THE FIBRES.

When the combing machine is used it is much less necessary for the drawing frame to exercise its power of making the fibres of cotton parallel to each other, as the former machine attends to that duty as well as effecting the separation of the short fibres from the long. Combing, however, is only performed in the comparatively few mills which are employed in producing yarns of a very good quality, and it is almost confined to fine spinning mills. Notwithstanding, the combing action which is undoubtedly set up in various parts of a carding engine, the fibres of cotton are by no means parallel to each other in the sliver that leaves the card. A cursory examination of the web of cotton as it leaves the doffer will reveal this fact to anyone

concerned. This is largely due to the condensing action upon the cotton set up by the doffer in taking the material from the cylinder, and again by the doffer comb in stripping the cotton from the doffer. About 26 yards of cotton on the surface of the cylinder are reduced to only one yard in length on the doffer by the difference in surface speeds between the two.

THEORY OF PARALLEL ACTION.

The particular action of the drawing rollers which results in the cotton fibres being laid in parallel order to each other, requires a little reflection before it can be clearly comprehended. It is easier to understand how the combing machine can make the fibres parallel, because in that machine the fibres are held for the moment by the nippers whilst the combs are passed through them. None of the parts of the drawing frame concerned in making the fibres parallel are at any time stationary. It is due to the fact that each pair of rollers that the cotton comes to revolve faster than those immediately preceding them, that the fibres are made parallel. Starting at the back of the machine, the cotton is fed to the first pair of rollers which pass it on until it is gripped by the second pair. These revolving at a greater surface speed than the first pair, try to take the sliver forward more quickly than it is given to them. An action is thus set up amongst the fibres which is almost equivalent to what would take place if the first or back pair of rollers were for the moment stationary. The fibres give way amongst themselves owing to the superior velocity of the second pair of rollers. The leading or front ends of one set of fibres, and the following or back ends of another set of fibres, act upon each other in such a manner as to cause a mutual straightening of all the fibres of cotton.

Probably the lecture diagram often used by the author in demonstrating this fundamental principle of cotton

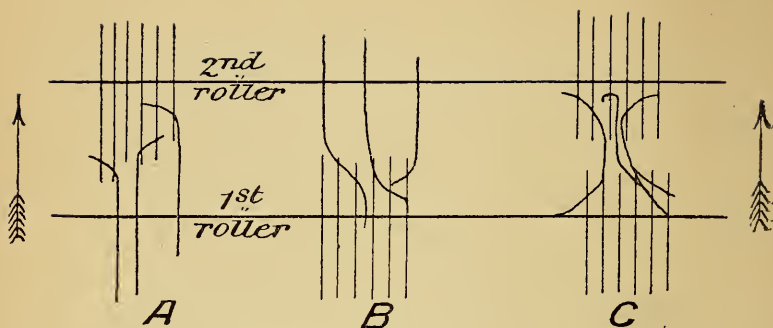


FIG. 6.

spinning to his own students will serve best for showing the point in the present article. Referring to Fig. 6, it is seen that the fibres of cotton in passing through the rollers can principally occupy three positions. They can be held by the first or back rollers only, by the second rollers only, or be between the two pairs of rollers without being gripped by either. In any one of these three positions there is a decided tendency to make the fibres parallel, or straight, simply on account of the action amongst the fibres caused by the second pair revolving faster than the first pair. At **A** it is assumed that the three fibres shown with their back ends held by the first pair of rollers have their forward ends crooked. Now, the other fibres intermingled with them and gripped by the second pair of rollers are moving along more rapidly than the non-parallel fibres. Clearly, therefore, this must have a dragging effect on the crooked ends of the back fibres, which must tend towards reducing them to a straight condition.

Again: At **B** three fibres are shown as being gripped by the second pair of rollers, whilst the back or following ends are loose and crooked. Now these three fibres are being carried forward more rapidly than the six that are

meshed with them, and at the same time are issuing from the first pair. Clearly, therefore, the forward ends of the six back fibres will exercise a cohesive action upon the crooked ends of the three front fibres, which will necessarily result in the latter being straightened.

Again: At **C** there are shown three fibres which are assumed to have both their front and back ends crooked, and at the same time are not held by either pair of rollers. A double action is taking place upon these fibres, tending to reduce them to parallel order. The six fibres passing through the second pair of rollers are drawing the front ends of the three crooked fibres forward. Simultaneously the six fibres passing through the first pair of rollers are exercising a cohesive effect on the back ends of the loose fibres, which causes a resistance to the action of the second pair of rollers. The amount of influence exercised by the rollers towards reducing the fibres to parallel order depends largely upon the relative speeds of the two pairs of rollers, and is, therefore, greater between those pairs of rollers which have the greatest draft between them.

THEORY OF DOUBLING.

Any practical man will be aware that the sliver as it leaves the carding engine is usually far from being in a uniform condition. If, say, for instance, a successive number of pieces of sliver, each six yards long, be weighed in rotation, it will usually be found that there is a considerable variation in the weights of the various six-yard lengths. As a matter of fact the author has often personally tested this with different styles of carding engines and different descriptions of cotton. Lengths varying usually from one to six yards each have been carefully taken off by the wrap reel, and as carefully weighed in the small scales usually provided for that special purpose. His experience and observation, therefore, lead him to

assert that, as a rule, card slivers will show considerable variation. There is not the slightest doubt that the simple action of doubling and drawing slivers together very rapidly effects a reduction in whatever inequalities previously existed. This can be demonstrated in various ways.

For the sake of illustration, we will assume that we have six pieces of sliver, each two yards in length, and the correct weight for two yards should be 96grs., which would be equal to $\cdot 17$ hank carding. Five of the slivers are the correct weight, but one of them only weighs 88grs., which is a considerable variation. We double these six slivers together at the first head and obtain a resultant sliver as follows :—

$$\frac{96 \times 5 + 88 \times 1}{6} = 94\cdot666\text{grs.}$$

We now double this sliver again with five correct slivers at the second head

$$\frac{96 \times 5 + 94\cdot666}{6} = 95\cdot777\text{grs.}$$

The operation being repeated at the third head, we obtain

$$\frac{96 \times 5 + 95\cdot777}{6} = 95\cdot963\text{grs.}$$

or less than $\frac{4}{100}$ ths of a grain of variation.

Again, suppose that all the slivers differed in weight, as follows:—91grs., 92grs., 93grs., 94grs., 95grs., 96grs. These six, doubled together, would give us from the first head

$$\frac{91 + 92 + 93 + 94 + 95 + 96}{6} = 93\cdot5\text{grs.}$$

After passing the other two heads the defect would practically be eliminated.

Instead of comparing the weights, we will compare the counts for hank carding and drawing, and take a fine hank and assume that eight slivers are doubled together in each case. Take a $\cdot 44$ hank sliver and assume that we have

seven correct slivers and one that equals a .40 hank. At the first head we obtain—

$$\frac{.44 \times 7 + .40 \times 1}{8} = .435$$

at the second head

$$\frac{.44 \times 7 + .435 \times 1}{8} = .4393$$

at the third head

$$\frac{.44 \times 7 + .439 \times 1}{8} = .4399$$

Clearly the defect is almost eliminated, there being only $\frac{1}{10000}$ th part of a hank error. Whereas at first there was an error of $\frac{4}{100}$ ths.

The same principle can be demonstrated in another way by a lecture diagram often used by the author to show the point to his own students. Assume, as in Fig. 7, that we have six slivers, each of which has three different thicknesses, **A**, **B**, **C**.

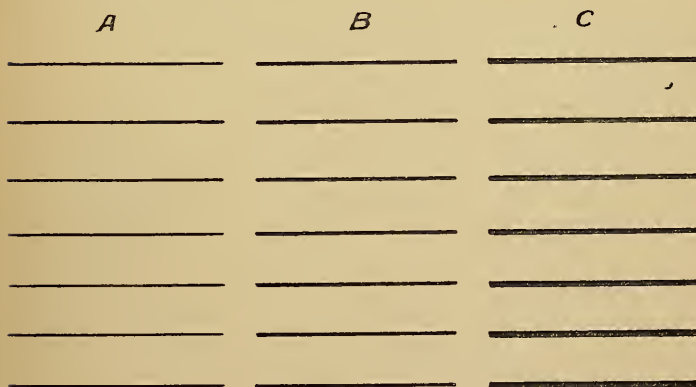


FIG. 7.

These thicknesses are represented by the numbers 1, 2, 3. **C** is three times as thick as **A**. Now in doubling these six slivers together there is just one possible chance for them

to come together, as shown in the lecture diagram, with all the thick places together and all the thin places together. This would give a resultant sliver just as irregular as the slivers put at the back of the machine, that is, **C** would still be three times as thick as **A**. But a moment's reflection will convince anyone that it is very unlikely that the slivers will come together as shown in the diagram. This is simply because there are quite a number of other positions they can assume instead of that one. The possible combinations of the six slivers are such that it is almost certain that there will be an amalgamation of thin places with thick ones to a considerable degree. This, of course, means that the irregularities will be reduced.

It would be just as easy to give further demonstrations, but it will be sufficient to point out that slivers pass through three heads usually which gives a vastly increased number of possible combinations of the thick with the thin places, and a consequent reduction of irregularities. It must also be remembered that in the lecture diagram we assumed that every sliver was wrong, and that to a very large extent. although no such extreme variation would ever occur in actual practice.

A thorough consideration of the preceding remarks will probably convince any candid-minded person that the principles of doubling as a means of finally producing an even yarn, are perfectly sound, and afford a solid basis or foundation to work upon towards that end. It may be just as well to remind some readers that the same principle is carried out to a less degree in some of the machines which succeed the drawing frame. Also it is carried out in the scutching room. Of course, on the scutchers we also adopt other means of reducing irregularities in the laps. These were formerly weighing and feeding, and are now the piano feed regulator and the Hopper Feeder, which are at this point of even greater importance than the doubling principle. This is probably due, however, to the limited

extent to which doubling can be carried out at this point. In the drawing frame with six up at each of three heads, we obtain a total doubling of 216 times; with two sixes and one eight we obtain a total of 288 times; while if three eights are ever resorted to we obtain a total of 512 times. If such a doubling power as the above could be readily and economically obtained in the scutching room we should have little need of piano feed regulators.

TOTAL DOUBLINGS.

A word may be said here in explanation of a point which is quite clear to those readers who have devoted some amount of thought to the subject, but which is nearly always somewhat of a mystery to beginners. The author has noticed that quite a large number of students at first imagine that we add the doublings in one frame to those in the other frames in order to get the total amount of doubling. Thus, for six at each of three heads, they take it $6+6+6=18$. A little reflection will show that it should be $6\times 6\times 6=216$. Six ends are doubled together at the first head. The sliver made from these at the delivery of the front head contains portions of six different slivers. Now, six of these are taken together, and each one of the six contains portions of six slivers, so that altogether it is $6\times 6=36$ at the second head. That is, the slivers made by the second head each contain portions of 36 of the original slivers. Then six of these are put up together at the third head. As each of the six slivers now contains portions of 36 different card slivers, the total amount of doubling is $36\times 6=216$. That is, the slivers made at the last head of drawing each contain portions from 216 of the original card slivers. This is on the same principle as multiplying intermediate drafts together in order to obtain the total draft instead of adding them together.

This principle may be well represented as follows :—

1st Head.	2nd Head.	3rd Head.
1 0 Sliver ...	6 0 Slivers ...	36 0 Slivers
1 0 „ ...	6 0 „ ...	36 0 „
1 0 „ ...	6 0 „ ...	36 0 „
1 0 „ ...	6 0 „ ...	36 0 „
1 0 „ ...	6 0 „ ...	36 0 „
1 0 „ ...	6 0 „ ...	36 0 „
6 Slivers.	36 Slivers.	216 Slivers.

At the second head it is shown that we must take 6×6 , and at the third head 36×6 . Occasionally in fine spinning, four heads of doubling are taken in order to rapidly increase the amount of doubling as we then get $6 \times 6 \times 6 \times 6 = 1296$, which must conduce to evenness. In some case four sevens are taken, thus giving $7 \times 7 \times 7 \times 7 = 2401$ doublings. This may do for some kinds of cottons but it would certainly not pay to do it for American. To illustrate this point in the calculation given for six heads a page or two previously, the eight grains variation in the sliver was reduced to .04 grains after passing through three heads, and we will carry the calculation forward to a fourth head.

$$\frac{96 \times 5 + 95.963 \times 1}{6} = 95.993 \text{ grains.}$$

After passing the third head, two yards of sliver, instead of weighing 96 grains, weighed 95.993. After passing the fourth head they weigh 95.993. In this case we only reduce the irregularities by $\frac{3}{1000}$ of a grain by using a fourth head. The first head reduces the irregularities much more than any succeeding head in every case, simply because the unevenness becomes so small that a sixth part improvement is scarcely perceptible.

This shows that it would not be at all a wise plan to increase drawing frames and reduce the numbers of bobbin and fly-frames. If four heads of drawing are thus shown

to be too many for ordinary cottons at any rate, how much more unwise is it to try five heads? Some people have tried this. with the result, however, that they have speedily reverted back to the old order of things. In addition to the only very slight advantage secured by increasing the draw-frames beyond the orthodox number, it must be remembered that on account of the loose, untwisted character of the slivers, and the quick speed of the draw-frame front roller, there is no process of cotton spinning which so rapidly elongates the fibres as the draw-frame. For long or very harsh staples only, therefore, is it likely that more than three heads of drawing would be advantageous, and for very soft cottons two heads are probably enough. It will be profitable to expend a few words in tracing the ultimate effect on the finished yarn which would be probably produced if no doubling took place. Suppose, as an exaggerated example, that a portion of the sliver from the card, say one yard was only three-fourths of the weight it should be. Assume six of a draft in each of the three heads of drawing frame, $4\frac{1}{2}$ in the slubber, $5\frac{1}{2}$ in the intermediate, six in the roving-frame, and eight in the mule. The one yard of sliver would be drawn into 256,608 yards of yarn, all of which would be only three-fourths the proper weight. It might be, say, 60's instead of 45's counts. Of course these conditions could not occur in practice, as no such drafts would be necessary if no doubling took place. Nevertheless it is quite fair to assume that the same amount of irregularity would be perpetuated. Perhaps a better way of stating the same principle than the above will be to assume the usual amount of doubling to take place with the above drafts, &c., but to assume further that the doubling has no effect whatever in reducing the irregularities. We should then get

$$\frac{256,608}{6 \times 6 \times 6 \times 2 \times 2} = 297 \text{ yards of yarn,}$$

every yard of which would be $\frac{3}{4}$ ths the correct weight, *i.e.*, it would equal 60's instead of 45's.

ARRANGEMENT OF GEARING.

In Figs. 8 and 9 are shown two diagrams which have been reproduced from the large lecture room maps presented to various Technical Schools by Messrs. Brooks & Doxey. In them is fully shown the arrangement of the gearing and driving parts of the machine and the actual sizes of the different wheels, etc. As usual the motion is received from the line shaft by the bottom cross-shaft. The driven pulley on this cross-shaft is shown at the bottom of Fig. 9, and its size is given at 19" $\times$ 4". A belt extends upwards from a 16" pulley on the bottom cross-shaft to 10" diameter fast and loose pulleys on the front roller of the drawframe. If a series of say three drawframes were arranged in a line with each other the same bottom cross-shaft would do for all three frames and there would be a separate belt extending upwards to the front roller for each of the three frames. It is worthy of note that motion is distributed to the different parts of the machine from the front roller of the drawing frame. This is not the case with any of the other machines. For instance, in the mule the central and chief motor is the rim-shaft, in the speed frames it is the jack shaft, and in the card it is the cylinder. The high speed at which the front roller of a draw-frame is run, combined with its strength and the lightness of the various parts of the frame, enables the power to be distributed very effectively from this roller.

The driving of the other three pairs of drawing rollers may first be traced. It will be noticed that a 20 pinion on front rollers drives a crown wheel containing 100 teeth. On same stud as the crown wheel is the change pinion which may usually be anything from 52 to 59, driving a 60

DRAWING FRAME

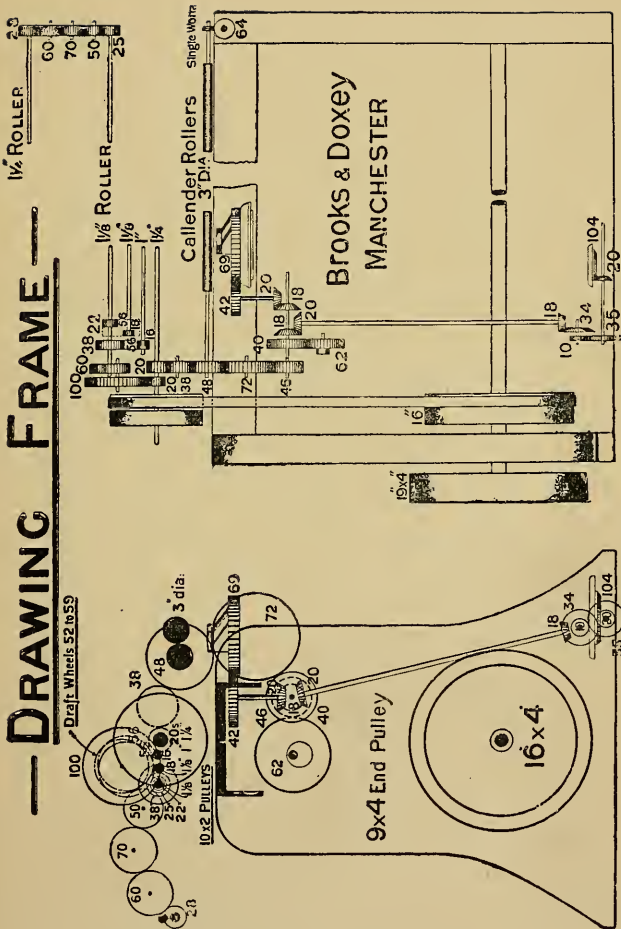


FIG. 8.

FIG. 9.

on the back roller. These are the wheels concerned in the total draft along with the diameters of the back and front rollers. A 34 on back roller drives a 16 on the second roller from the front by means of a 56 carrier wheel. A 22 on back roller, by means of another 56 carrier, drives an 18 on third roller from front. In this style of gearing the driving of the two intermediate rollers is effected in exactly the same manner as the driving of the middle roller is effected from the back roller in the mule, or ring frame, or in the speed frames. Going to the other end of the back roller in both Figs. 8 and 9, it is seen that a 25 on this roller drives through three carriers containing 50, 70, and 60 teeth respectively, a 28 on the lifting roller. This roller is $1\frac{1}{4}$ diameter, and has for its object the lifting of the slivers from the cans at the back of the machine. On the top cross-shaft, which drives the coilers, is a 46 wheel driven from the front roller by means of the carriers 38, 48, and 72. The 48 carrier just mentioned is fixed on the end of the bottom calender roller, and thus the latter is driven from the front roller. As shown in Fig. 9 the calender rollers are three inches diameter.

On the other end of the calender roller in Fig. 9 is shown a single worm driving a 64 worm wheel in connection with the full can motion. Motion is now imparted by the top cross-shaft to three different parts of the machine. The stop-motion parts are driven by a 40 on the top cross-shaft gearing into a 62 eccentric wheel. On the top cross-shaft is an 18 bevel driving a 20 bevel on the top of the upright shaft. At the bottom of this shaft is an 18 bevel driving a 34 stud wheel bevel. On same stud as the 34 is a 10 pinion driving a 35 wheel on coiler bottom shaft or can-coiler shaft. A 20 bevel on this latter shaft drives a 104 bevel on can bottom disc or dish. Referring again to the top cross-shaft, a second 18 bevel is shown driving a 20 bevel on upright stud. On the other end of this stud is a 42 spur wheel driving a 69

coiler top wheel or disc. The top cross-shaft and the coiler bottom shaft, are extended along the frame so as to drive the other can-motions.

STOP MOTIONS.

Probably the most important adjuncts to a draw-frame are the automatic stop-motions. This is so, whether we consider the stop-motions from a mechanical point of view, or from the point of view of usefulness. The construction and action of the parts are decidedly ingenious, and their object is chiefly to aid the draw-frame in performing its object of making an even sliver. An ordinary draw-frame stops upon the fulfilment of any one of three conditions:—

1st.—When an end breaks or runs very light, or a can becomes empty at the back of the machine.

2nd.—When an end breaks or runs very light at the front of the machine before passing through the calender rollers.

3rd.—When the front cans are full and require replacing by empty ones.

When any one of these three things occurs, one end of a spoon, or in the case of a full can-motion, often one end of a peg, moves into a fresh position, so as to intercept and prevent the movement of a rocking-shaft. The result is that an iron bar is lifted off a catch, and then slid an inch or two longitudinally by a spiral spring. In its movement it takes along the stop-rod, and thus stops the machine by placing the belt upon the loose pulley. The machine cannot then be started again unless the defect is first remedied, if the parts are in proper working order.

These motions differ in detail as constructed by different makers. The simple lecture diagram in Fig. 10 is intended merely to indicate the principle upon which the stop-motions work, and not to represent actual construction in

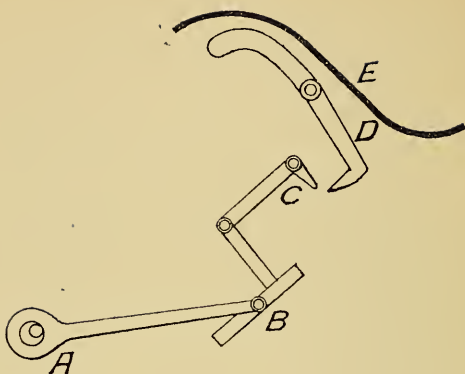


FIG. 10.

any instance. There is an eccentric at **A** driven from the front roller. By its revolution it imparts a horizontal motion to the rod **A B** after the style of the eccentric used on a steam engine for opening and closing the port holes. At **B** the stud in the shaft rests in the slot of the bell crank lever **B C**, and this crank is thus oscillated. The spoon **D** is unevenly balanced with the bottom end heavier than spoon, the top end. So long as the cotton **E** rests upon the the latter, it is held up. When the sliver fails, the bottom end of spoon **D** comes in the path of the bell crank at **C**. The bell crank therefore is arrested in its motion. The eccentric keeps on revolving, and the stud **B** therefore slides up the slot at **B**. In its upward movement it releases the rod for stopping the machine. A similar effect, but by different connections, stops the machine in the other cases. In Fig. 11, is illustrated a recent improvement in stop-motions by Messrs. Asa Lees and Co. The motion is given in detail for the benefit of readers who desire to study the subject closely. In Fig. 11, *a* is part of the frame of the machine, *b* a plate which carries brackets *b*¹ for the balanced back spoons *c* which have hooks or projections *c*¹,

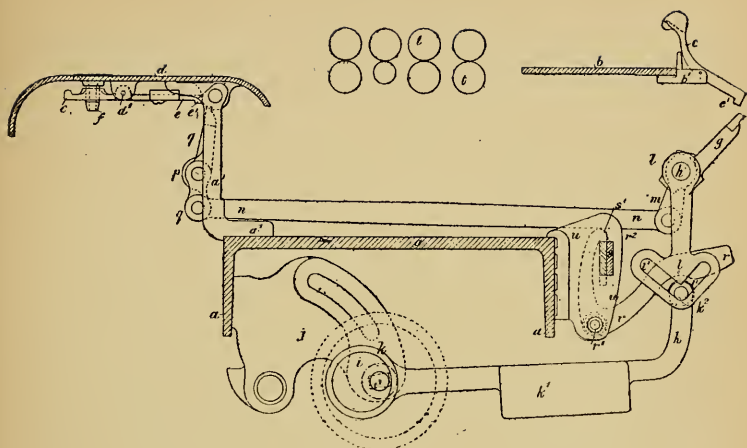


FIG. 11.

and *d* is a plate at the front of the machine supported by *a*¹ bolted to the frame *a*; to the underside of the plate *d* pivoted at *d*¹ balanced levers *e* which have hooks or projections *e*¹ and carry the front funnels *f*. The balanced back spoons *e* are adjusted in the ordinary way so that when a sliver breaks or fails the corresponding spoon *c* is acted upon by a striking lever *g* secured to a shaft *h* which is caused to oscillate by means of an eccentric *i* mounted on a shaft *i*¹ carried by a bracket *j* bolted to the frame *a*, the eccentric is surrounded by a strap *k* at one end of an arm weighted at *k*¹ and carrying at its end a stud *k*² which normally rests at the bottom of a V slot *l*¹ in a bar *l* which is secured upon and carried by the shaft *h*; the to and fro movement of the eccentric *i* is imparted to the bar *l* which causes the shaft *h* and striker *g* to oscillate so long as the stud *k*² rests in the bottom of the V groove.

On the oscillating shaft *h* is a short arm *m* pivoted to one end of a rod *n* which at the other end is pivoted to the arm of a lever *q* fulcrumed on a stud *p* carried by one of

the stands a^1 ; the upper portion of the lever q moves to and fro under the free end of a balanced lever e and acts as a striker to engage with the lever e when a sliver breaks.

When the drawing frame is in motion and all the slivers are passing through the back spoons c and front funnels f the oscillating strikers g and q move backward and forward without encountering any obstruction; but in case a sliver passing over a back spoon breaks or fails the lower or weighted end of the spoon c swings down in the path of its striker g which catches the projection c^1 either on its forward or backward stroke and before the striker can make more than half a complete stroke its movements is arrested and the stud k^2 moves up one path of the **V** groove l^1 thereby coming under and lifting the end of a lever r pivoted at r^1 and moving back its hooked end r^2 from a projection s^1 on the starting rod s thereby allowing a spring, not shown, to draw the rod s along and move the driving strap from the fast to the loose pulley and stop the machine before the broken end of the sliver is drawn into the drawing roller t .

In a similar manner if a sliver breaks between the rollers t and the funnels f its balanced lever e falls and the projection e^1 thereon lies in the path of its striker q whether the latter is moving backward or forward whereby the stud k^2 is caused to move up the **V** slot l^1 and stop the machine as before described.

ELECTRIC STOP-MOTION.

The electric stop-motion, invented by Mr. Joseph Smalley, has now for some years been very successfully applied by the firm of Messrs. Howard and Bullough, of Accrington. It is now firmly established as a part of their firm's drawframes, and it is not at all unlikely that in the course of time it will receive even more extended application.

The mechanical spoon stop-motion, particularly when all the parts are kept well cleaned and accurately adjusted, is certainly an effective and ingenious arrangement for stopping the frame upon the fulfilment of the proper conditions. There is no denying, however, that it contains a great multiplication of parts, each demanding separate adjustment and attention, and this is probably its one great defect. To show this point we may take as an instance a frame of six deliveries and three heads. At the back of this machine there will be 108 of these delicately balanced spoons. If a mill contained six sets of such boxes there would be 648 of these spoons to bestow attention upon.

It is the author's experience that there is some tendency for the spoons—and more particularly the front spoons—to get entangled with dirt and to stick, and otherwise to become tardy in their action, with the consequent result that “single” is formed. Sometimes the broken sliver may remain on the spoon, and prevent its action. A good carder recognising this point will be careful to see that the spoons are frequently cleaned. The electric stop-motion depends for its action upon the fact that cotton is a non-conductor of electricity, and, therefore, it is used to prevent the positive and negative poles of electricity from coming together, and so completing the circuit of electricity and stopping the machine. It automatically stops the frame upon the fulfilment of any one of four conditions:—

1st.—When a sliver breaks or a can becomes empty at the back.

2nd.—When an end partially or wholly breaks between the front roller and the calender rollers.

3rd.—When the cotton laps round the front roller.

4th.—When the cans are full at the front of the machine.

The stopping of the frame by any of these conditions is always brought about by the mere contact of two

surfaces. In two out of the four cases—the back and front stop-motion—it is the absence of the cotton which causes the metallic surfaces to touch. In the case of the roller lap and full can stop-motions, it is the presence of too much cotton which raises one surface into contact with its electrical opposite surface, and this contact, by causing the magnet to operate, instantly stops the machine. It must especially be noted that mere contact of two dead or plain surfaces is sufficient to stop the machine. To describe these four parts of the stop-motion more in detail, we may say that the first stop is for the failure of the sliver at the back. The slivers on their way to the fluted drawing rollers pass through top and bottom rollers similar to the single preventer rollers now adopted with many of the spoon stop-motions. The bottom roller is fluted and long and runs in bearings on the frame. The top rollers are only of sufficient length to rest upon two slivers each. They run in brackets on the back plate, which latter is electrically insulated from the rest of the frame, as are the top short rollers. These short top rollers are therefore in communication with one pole, whilst the longer bottom rollers are in communication with the other pole of electricity. If they touch each other the circuit is completed and the current will pass and give attractive power to the magnet. This occurs upon the failure of a sliver allowing the top and bottom rollers to come into contact. At one end of the machine is an electro-magnet, which, when the current passes, becomes operative and attracts a pendulum catch into the path of a revolving cam and causes these to actuate the driving belt rod and stop the machine. If the sliver breaks in front, between the calender rollers and the front drawing roller, the calender rollers are utilised in the same manner as the single preventer rollers at the back. The calender rollers are insulated from each other, and when a sliver breaks they come into contact and the current passes, as just described, through the magnet

and stops the machine. In the third instance, let it be supposed that the sliver at this point only partially breaks, and, therefore, runs light. The broken portion of the sliver will collect in front of the rollers, and will either choke up the funnel over the coiler, or lap on the front drawing rollers. In the first instance, the sliver will break and the machine will stop. Also a stoppage will be effected in the latter case as follows: It may lap on either of the front rollers, and whichever it laps on, the top roller will be lifted up until it makes contact with a pin or stud of different electrical pole, when the current passes and a stoppage results. The fourth part of the motion is the full can stop-motion. In this case, when the can is sufficiently filled, it lifts the tube wheel slightly, and thereby completes the circuit, with the result that it is stopped as before. Any one of the front cans is capable of thus stopping the machine. In some of the spoon stop-motions, a stop-motion is applied to one coiler only, and this coiler has, therefore, to act as a guide to the others. In such cases there is some risk of damage by the cans overfilling.

Readers may be just reminded that the subtle agency of electricity is successfully finding its way into cotton mills in several capacities. We have electric light, electric buttons for stopping the main engine, electric lamps with which to light up, etc. In all these connections, electricity exhibits its wonderful power, and the electric stop-motion is by no means the least successful of these applications. The electric current is supplied by a small magneto-electric machine which is driven by a small belt or band from the the line shaft. The driving power required is very small, and the electricity is always available so long as the engine is running. To a less degree than in the case of the drawing-frame, the electric stop-motion has been applied to the bobbin and fly frames. Take the case of an intermediate frame the object of its application is to prevent

the evil of single caused by only one end passing through the drawing-rollers instead of two together. There is an electric roller, round which the ends pass before they reach the back draft roller. The failure of an end, either through the cotton breaking, or a bobbin becoming empty, will cause electric connection to take place with this roller and thus stop the machine. The author, ought to remark however, that he is conversant with several practical men, who, whilst speaking highly of the electric stop-motion for draw-frames, do not care much for it on the fly frames, whereas, others are of the opposite opinion. Also there is no doubt that most practical men are quite satisfied with the spoon-stop-motion for draw-frames.

THE ERECTION OF A DRAW-FRAME.

As in the erection of nearly all the machines, the first thing requisite is to get the proper centre lines. Having determined the position of our draw-frames, we may drop a plimbob with a pointed end from the line shaft, say about a yard to one side of the intended position of the draw-frame. Carefully make a mark at the exact place at which the plimbob touches the floor. Then a little further on, say about a yard on the other side of the frame, drop the plimbob a second time, and again mark the floor. The two marks on the floor should now be connected with a chalk line. We have thus established a true centre line from which others may be extended. The frame ends and the frame driving pulleys will require to be set parallel to this line. Extend a second line at right angles to the first of any required length. If the set of frames we are putting up are to be all in the same straight line, end to end, it will be necessary to make the second chalk mark of some considerable length. Each frame must have its drawing pulleys and frame ends at right angles to this second mark and its roller beam parallel thereto. When frames

are to be put back to back, it would be as well to make the first line of considerable length and extend shorter lines at right angles thereto.

Having got the requisite centre lines we may proceed to set up the frame ends and the roller beam. This is a much simpler operation than on a mule, or even on a bobbin and fly frame, on account of its being so comparatively short. The roller beam being placed in position it should be levelled up by placing a spirit level on top and inserting wood packing under the feet of the frame ends to a sufficient degree to obtain a level beam. This being attended to we may proceed in the same manner with the other boxes. Whether the boxes are to be set end to end or opposite each other we can fix the frame ends and roller beam in a similar manner to the first box. We may now at the first box adjust the brackets for carrying the throw wheels, and which also sometimes carry the gearing for driving the above. Afterwards the arm brackets from the roller beam for carrying the calender rollers may be fixed, and the calender rollers then placed in position. Then the front sliver plates may be fitted to their places, and the four lines of fluted iron rollers may be put in their places on the roller beam stands. It is unlikely that the roller stands themselves will need much attention as they will have been undisturbed if it be an old frame that is being put up in a fresh place. If it be a new frame the stands will have been fitted all right in their places before leaving the machine works.

Next, when setting roller stand slides, we may set on the back plate, which is fastened to the back slides, and adjust the top flat-brackets so that the flats will be in a straight line with the rollers. Following this, the inclined plates carrying the spoons, and from which is hung on small brackets, the cam motion shaft, might be fixed. The cam motion shaft should be quite free in action. This is an awkward thing for a novice to interfere with. Then

set the cams in such a position that the ends of the spoons will act against the cam at the proper time so as to knock the box off. Afterwards the cam shaft may have fixed on it, or to it, the reaching lever, the front part of box, and these parts set in such position that the end of the trumpet levers will work knocking-off motion and stop the box at the proper time.

As regards the setting of the spoons, if no stuff is in the machine a piece of iron about a quarter of an inch thick may be placed on the end of each spoon to keep it down and out of the way of the cam. In setting the back spoons we may weight them {and try them one after the other. In adjusting the cam plate see that it knocks off properly. The front trumpets, in setting, may be weighted and tried one after the other to see if they will act by turning front roller round by hand to give motion to the knocking-off shaft. Adjust each lever in front and cam plate behind so as to give quick action in knocking off.

If the sliver is in the machine the ends may be pieced up and then broken so as to try each spoon and the cam-plate to see if the machine is promptly knocked off. In regard to the front trumpets, if the sliver be on the machine each end may be broken while running, and the action of the trumpet noted. The coiler and can motions may next be attended to. Some care ought to be observed in adjusting each can bottom as the manner in which the coils are deposited in the can will, to some extent, depend upon the correct setting of the can bottom. The following procedure may be adopted in adjusting this portion of mechanism:—Fix a small gauge or magic in the coiler top, and from a hole in the centre of this gauge drop a plumb-bob down to the foot plate. We may be intending to set the centre of the foot plate, say $1\frac{1}{2}$ inches out of centre with the centre of the top plate in order to get the coils of sliver deposited properly in the can. If this be so, we may measure $1\frac{1}{2}$ inches from the plumb-bob to one side and at

this point establish the central pivot for the foot plate or bottom disc.

REPAIRING OF DRAW-FRAME.

There are few parts about a draw-frame, which, by their rapid revolution or heavy running, are liable to considerable wear and tear. In an ordinary spinning mill there is no machine of importance that requires as little expenditure on repairs as the draw-frame. There are, however, some details that are subject to deterioration in the course of time, and these we will briefly discuss.

IRON ROLLERS.

The iron rollers of a draw-frame revolve at a comparatively rapid rate, and are often of larger diameter than the iron rollers in any of the other machines. The necks of the rollers and the brass bits on the stands are, therefore, liable to wear, resulting in the iron rollers lying lower down than they should do. Also they are caused to bear to one side instead of assuming a fresh position in exactly the same plane as before. This often causes the top rollers to press hard against the dividing nebs on top, and the leather roller ends become dry sooner than they would otherwise do, causing a retardation of the top rollers and irregular drawing of the slivers. One of the first operations, therefore, should be to renew all worn brasses, and also to bring the roller stands and iron rollers into good condition in other respects. Care should be exercised to line the stands up so that the rollers shall revolve freely in their bearings. This will be an easy matter, as the frames are so short.

CALENDER ROLLERS.

These run at a comparatively high rate of speed, and are also heavy, and are therefore in the course of time

liable to wear at the bearing surfaces. The consequence is that less pressure is put on the sliver, and the latter is not drawn forward with the regularity that it should be. The sliver being drawn forward sluggishly, it sometimes happens that it licks up the dirt and fly from the front plate—at any rate in some old frames—and the fly is thus drawn forward with the sliver. This is perhaps more particularly the case where there is no draft between the front roller and the calender rollers. The ends, or bearing surfaces of the calender rollers, may have cast iron bushes put on them to compensate for the wear. On some frames the two calender rollers are level with one another, or in the same horizontal plane. In other cases one calender roller is placed slightly higher than the other, and rests upon the lower roller. A good method of testing whether the calender rollers are working efficiently is to put thin paper between them and into their grip at different portions of their length. The paper should be held firmly by the rollers, and when pulled at should have a tendency to tear before being released.

FAST PULLEY.

This should always be kept absolutely firm in its hold upon the front roller. The connections between the roller and the pulley are liable to work loose in the course of time, and the practical defect resultant therefrom is a sudden throw or shock in starting the frame and a backlash which may injure the slivers. The importance of this remark will be more readily seen when it is remembered that drawing-frames are perhaps more subject to frequent stopping and starting than any other machine in the mill.

SPOONS.

These should be taken out and cleaned at frequent intervals, as they are liable to get blocked up with fly and dirt and to act slowly, with the result that the ends of the

broken slivers get through the back rollers before the machine knocks off. The same remark applies to the front trumpets.

REACHING LEVER.

The stud for this may become worn, which will result in the lever losing some of its throw, and consequently knocking frame off late and causing waste between front roller and calender roller, as the breakage of an end at front would allow the sliver to keep teeming on to the front plate if the frame did not knock off. If this should become worn it is essential that it be renewed.

COILER FOOT PLATES.

The centres of these should be set in correct position as described in the erection of a draw frame, in order to secure the sliver being correctly deposited in the can. There is another important matter in connection with these foot plates, not previously mentioned, and which is equally as important as the other. The rigid foot plates should be set perfectly level with the spirit level.



FIG. 12.

The importance of this remark may be seen by reference to fig. 12. Suppose the foot plate be $\frac{1}{16}$ th inch down at **A**, it is easy to see that at **B**, the top of the can, there would be a very considerable deviation from the correct position of the can top. This would effectually prevent the coils of sliver from being placed in the can properly. Also the sliver would break more frequently, causing extra stoppages both at this and the next machine. All connections of the stop-motions should be placed in the best working order. All wheels and studs should be put into good condition. The top rollers should be re-covered, if necessary, and carefully set. It would also be as well if the stationary flats were re-covered with flannel. The saddles, wires, and hangers appertaining to the rollers should be reduced to good working order. If each foot-plate be attended to in above manner, and the various cans, wheels, weights, saddles, &c., be put to their places, the frame will be ready for starting. Where it can be done it is a good practice to put the foot-plates below the floor surface in order to get a lower frame, which is a more convenient arrangement for operatives of low stature. Where the floor of the mill will permit, some firms place the top of the can bottom motion about $4\frac{1}{2}$ inches below the upper surface of the floor, making the frames correspondingly lower. Of course it has to be known beforehand whether the higher or the lower frame ends will be required. It is the general practice to use cans 36 inches long, and mostly 9 inches diameter.

CLEARERS.

These are an essential and important part of the draw-frame. They are, indeed, essential for good work in all the machines which succeed the draw-frame. They are, however, of greater service in the draw-frame than in any of the other machines. This is due to the character and quantity of the cotton or sliver that is passed

through these machines. The thick body of fibres that compose the sliver are loose and untwisted and very subject to electrical disturbance. They therefore adhere to the leather-covered top rollers with comparative ease and in considerable quantities. This is worse at the last head than at the first inasmuch as making the fibres parallel does not make the sliver stronger or firmer but the reverse. It is only when twist is imparted to the material at the slubber frame that the strengthening effect of making the fibres parallel begins to be evident. Evidently if no means are provided of taking up the loose detached fibres they will prove a grave source of detriment to the sliver. They will continually accumulate and at intervals be carried along with the sliver. In actual practice one or another means is always provided for clearing the rollers. These means, however, have never been regarded as altogether satisfactory by practical men, and the subject has caused them as much uneasiness and trouble as any other in connection with the drawing frame. Particularly has this been the case where yarns of a high quality have been required. The most common method at present adopted is the stationary flat. This consists of a flannel-covered board, lying along the top of all the four rollers, and being of a convenient length. These flats press on the rollers simply by their own weight, and thereby enough friction is set up to cause the loose fibres to adhere to the rough surface of the flannel. These are certainly effective when properly cleaned, but are always open to the objection that there are no means provided to carry away the flat waste, so that it gathers in lumps, which are often carried forward by the sliver. To prevent this the tenters have to pick the flats every two or three hours. Some carders, however, will not have them picked more than twice a day, alleging that with a slight ridge of waste on they clean the rollers better. To avoid the frequent picking of the

flats, and to secure an improved method of clearing the leather rollers, a considerable number of patent clearers have been devised and tried at different times. The most successful have been revolving cloths driven by weighted rollers inside a continuous band of flannel; a tightly stretched band (the waste removed by combs) of flannel driven positively and weighted rollers covered with flannel between the first and second, and again between the third and fourth rollers. Fig. 13 illustrates a recently invented type of clearer which has been adopted by Messrs. Dobson & Barlow with very good results. It consists of two flannel covered rollers. One of them rests upon the first and second rollers, and is driven positively at such a speed as to prevent any damage to the leather rollers, and yet so that it can clear the leather of any loose fibres that may

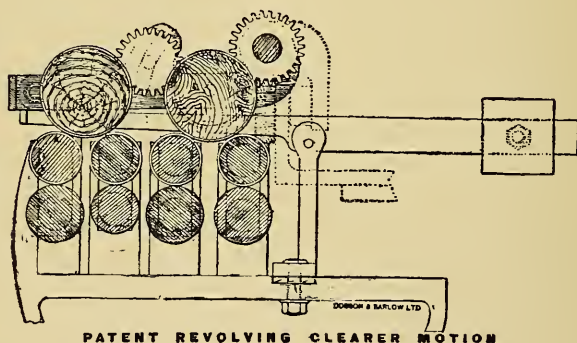


FIG. 13.

be attached thereto. The other roller is not driven positively, but simply rests on the third and back rollers. This is revolved by friction exactly in the same manner that the clearers of a mule work. Another pair of patent clearers, made by the same firm, are shown in Fig. 14.

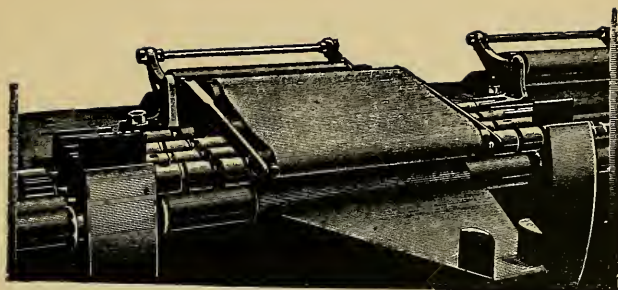


FIG. 14.

SINGLE PREVENTER ROLLERS.

Referring again to Fig. 5, page 15 a pair of rollers are seen at **D** which are placed between the spoon levers and back drawing rollers. These are a comparatively recent addition to draw-frames. Their object is to aid the back stop-motion in performing its work more promptly and efficiently; also, their use involves less strain on the sliver in lifting from the can. The bottom rollers are driven from the back drawing roller, as shown, at a somewhat less rate of surface speed in order to obtain a slight draft between the two sets of rollers. The top rollers are driven by frictional contact with the bottom rollers, and are usually only of sufficient length to rest on two or three slivers. Sometimes this extra pair of rollers are placed after the spoons. The use of these rollers allows a greater pressure to be put on the spoons, and the tension on the sliver between these extra rollers and the back drawing rollers is more uniform. As a consequence, they act more promptly than before. Those familiar with the action of drawing frames will be aware that on frames that are without these single preventer rollers the tension on the sliver is irregular. Sometimes the sliver is slack, almost sufficiently to allow the spoon head to rise and the frame

to stop. At other times there is too much strain on the sliver. It may also be noted that the slight draft that takes place between these extra rollers and the back drawing roller means so much less in the rollers. To fully appreciate this latter remark we will assume that at this point there is a draft of 1.10, and $5\frac{1}{2}$ total draft in the rollers and between the drawing rollers and the calender rollers. The $5\frac{1}{2}$ total draft will be increased to

$$1.10 \times 5.5 = 6.05$$

by having 1.10 at the back of the frame as indicated. With this appliance breakages of sliver will generally take place between the back can and the single preventer rollers, and therefore there will be small chance of the ends of the slivers passing through the drawing rollers and making single before the machine knocks off, particularly as the spoons will act more promptly. The top rollers, being short, can easily be turned up or lifted up whilst a broken end is being pieced, and to aid in this respect some firms with special rods and hinges.

CORRUGATED DRAWING ROLLERS.

At the present time in some few of our old mills there is a type of drawing roller used in the drawing frames for the back rows and second from back rows called the corrugated roller. Formerly, a great many of these were applied to drawing frames in different parts of the country, although they were not used for front row and second from front. These corrugated rollers differ from the ordinary iron rollers by being more deeply indented or fluted, and the top roller instead of being covered with leather is also deeply fluted similar to the bottom one, so that the two work together with the flutes of one roller meshed into the flutes of the other roller almost like geared wheels. In the very few places where these rollers are still at work the size of the draft change pinion has to be reduced somewhat, say,

equal to about 1 in 20 less than with leather covered top rollers. This is because the deep flutes give the rollers a greater circumference. Long since, however, a re-action set in against these rollers on the ground of uneven drawing and the fluted edges of the top rollers riding upon the fluted edges of the bottom rollers, and one or two other little evils. Consequently in many cases where the old frames have been retained, the corrugated rollers have been changed for the ordinary type. Possibly no notice would have been taken of these deeply fluted rollers in this treatise had it not been that quite recently identically the same principle has been again revived and one or two improvements effected in them which profess to completely remove the evils above indicated. There must be some show of reason for the professions, inasmuch as already many firms have adopted these patent rollers. Furthermore, they are now used for all four lines of top and bottom rollers. They are described below.

METALLIC DRAWING ROLLERS.

These are the invention of Messrs. Dunham and M'Kemie, of Holyoke, Mass., U.S.A. A company has been formed for making them, termed the Metallic Drawing Roller Company, to whom the author is indebted for the illustrations of them given herewith. The bosses of both top and bottom rollers are fluted similar to a gear, but with a special shape of flute or tooth, which is the result of considerable experiment. The top and bottom rollers are exact counterparts of each other, except that the top rollers are necked for saddle bearings, and are in short lengths in the usual manner. The principle of these rollers is clearly shown in figs. 15 and 16.

They are provided with collars shown at **AA**, in fig. 15, and more prominently illustrated in fig. 15. The collars are identical in action with the shrouding sometimes used

in heavy gearing to strengthen the teeth, being made the exact pitch diameter of the teeth or gear. These collars touch and move in pure rolling contact, after the style of the flats and revolving disc in a certain type of card. The collars thereby prevent the points of the teeth from coming in contact with the bottom of the flutes or grooves. The flutes are also made narrower than the grooves. The separation of the rollers by the collars affords space for the sliver, and thereby prevents the crushing and cutting of the fibre, which has proved fatal to all other attempts to run interlocking or corrugated rollers in the past. The space referred to is clearly shown in fig 15 at **BB**, and is sufficient to permit the cotton to be compressed within the limit of its elastic capability, which gives the drawing effect of a covered roller without any of its disadvantages. The collars, which are hardened to resist wear, serve as a bearing for the top rollers to rest upon, and allow the flutes of top and bottom rollers to mesh into each other. Their main object, however, is to act as separators.

In the ordinary leather covered top rollers the cotton or sliver is nipped or held by the top roller being heavily weighted, in order to give sufficient drawing power. With the metallic rollers the "bite" or "nip" is at the point of contact of the interlocking flutes, being distributed through the number of flutes simultaneously engaged. This gives a positive hold on the fibres. Granting that these metallic rollers can be made to work well and give even drawing at first, a moment's reflection will show that they will be afterwards cheaper and more efficient than the leather covered rollers. Roller leather is expensive, and is often allowed to run too long, with consequent bad drawing. The necessity of varnishing drawing frame rollers more than any other rollers in the mill is well enough known. Of course with the metallic rollers the expense and trouble of leather and varnish are saved. Masters will appreciate these points, and tenters, in particular, will appreciate the

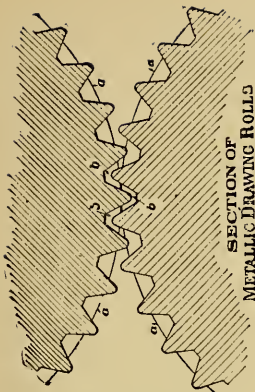


FIG. 15.

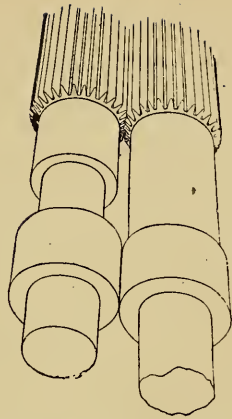


FIG. 16.

latter point, as some of the varnish used smells badly, and the frequent application of varnish is troublesome to the tenter. A point not generally appreciated but probably none the less true is that with the leather rollers, the part of the sliver in immediate contact with the bottom roller, is extended more than the part in contact with the top roller. There is probably not much in this point, but it cannot take place with the positive grip of the metallic rollers. The heavier the sliver and greater will be the evil referred to with leather covered rollers. A fact worthy of notice is that while with leather covered rollers the draft generally comes out less than the figured draft; with the metallic roller the reverse is the case, which proves that there is less slippage in the new method. As there is no leather to contend with, the bad effects of electricity, and damp, sticky weather, or "dog-days" cannot affect the cotton and varnish and leather. As referred to in the case of old corrugated leather rollers, the flutes in the rollers have the practical effect of increasing their circumference, and therefore with the same revolutions per minute of rollers there would be more production with the metallic system. The

flutes or indentations always give a species of crimping to the cotton which is intensified because the bottom roller flutes are driving the top roller through the cushion of cotton between them. This crimped effect generally alarms practical men when they see it for the first time and its exact amount is a matter of some uncertainty as yet, and this point hinders the correct working out of the drafts. The fluting produces a draft of itself, so that for a draft of, say, six, it would be as well to figure for a draft of

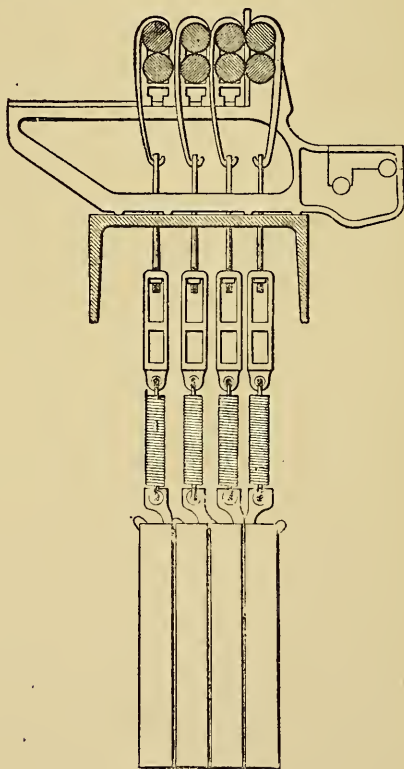


FIG. 17.

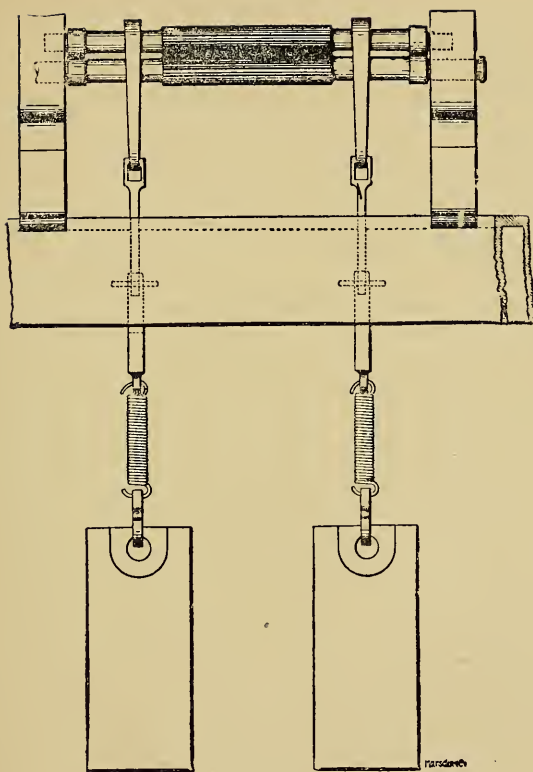


FIG. 18.

slightly less than $5\frac{1}{2}$. So far from regarding this crimping of the sliver as an evil, the Company contend that it is a good thing. They allege that the crimp condenses and unites the fibres so that the sliver is thereby strengthened and licking up of fibres prevented. In any case it is an essential accompaniment of the principle. The weight necessary to be put on the top rollers with this system is only about half to two-thirds of what is necessary

with the leather rollers. The method of weighting is shown in Figs. 17 and 18.

The metallic rollers are so far much more widely used in America than England. Further, although the system has been applied to the processes beyond the drawing frames, it has by no means as yet made the same headway in those processes as in the case of the drawing frame and for railways heads. It remains to be seen whether the experiments which English spinners are now making will lead to the general adoption of the roller for drawing frames. Certainly nothing in the economy of cotton spinning has been more ardently desired than an efficient substitute for the leather-covered rollers. Setting aside the shell roller or loose boss of Evan Leigh, and the more recent loose ends to the rollers, the top rollers remain now in almost the same state as when Arkwright, or somebody else, brought drawing rollers out, more than a century ago.

PRODUCTION OF DRAWING FRAME.

Dia. of front roller.	Revs. of front roller per minute.	Weight of sliver per yard in grains.	Hank.	Lbs. per delivery in $56\frac{1}{2}$ hours.	Lbs. per delivery in 10 hours.
Ins.					
$1\frac{1}{8}$	400	66	·126	1020	180·54
„	„	60	·138	928	164·25
$1\frac{1}{4}$	350	60	·138	897	158·76
„	„	54	·154	807	142·83
„	„	48	·173	717	126·9
$1\frac{3}{8}$	300	48	·173	679	120·18
„	„	44	·189	623	110·27
„	„	40	·208	565	100
$1\frac{1}{2}$	280	48	·173	692	122·48
„	„	44	·189	634	112·21
„	„	40	·208	577	102·12
„	250	40	·208	515	91·15
„	„	36	·231	463	81·95
„	200	40	·208	411	72·74
„	„	36	·231	370	65·49
„	„	30	·277	308	54·51

CHAPTER III.

BOBBIN AND FLY-FRAMES.

INTRODUCTION.

Very early in the history of what may be termed the modern system of cotton spinning the bobbin and fly-frame was adapted to the preparation of roving for the creels of the spinning machines. As the application of drawing rollers for making the roving thinner was combined with the flyer and spindle for winding the material on the bobbin, it is only likely that the name of Arkwright should be inseparably connected with this, as with other cotton spinning machines. We may just notice that the very same difficulty which was long an obstacle in the path of progress of the self-acting mule was also the chief hindrance towards establishing a permanent and vastly important position for the bobbin and fly-frame. We refer to the difficulty experienced in each case of providing means for successfully and economically winding the attenuated roving upon the proper apparatus. The parallel does not end here. Richard Roberts' differential winding motion for mules, the mechanism of which is centred in the quadrant, was introduced about 1830. The winding difficulty on the bobbin and fly-frame was largely overcome only three or four years before this by the patenting of Houldsworth's Sun and Planet Motion. Both the inventors were Manchester men, and both inventions

are largely in use at the present time. It will, however, be hereafter noticed that several styles of differential motion for bobbin and fly-frames have been recently introduced with a considerable amount of success. The bobbin and fly frames are chiefly concerned in attenuating the cotton to a sufficient degree to thoroughly prepare it for the creels of the spinning machines. Incidentally, as it were, these machines also render valuable service in other ways. Chiefly owing to the "draft" or "breakage" of the material between the front and second drawing rollers, a considerable amount of fine dirt, leaf, &c., drops off the cotton in its passage. By doubling two ends together at the back of all the machines except the slubber, imperfections in the evenness of the roving are further reduced. The fibres of cotton are also by these machines brought into still greater parallel order with one another. The average number of bobbin and fly frames employed is three—slubbing, intermediate, and roving. In low numbers, say below 20's, where less attenuation of the material is necessary, and sometimes when a lower quality of yarn is required in higher numbers, the intermediate frame is often left out. Occasionally the roving frame is left out instead, and the intermediate frame bobbins are placed in the creel of the mule. On the other hand, for very fine numbers of yarns, a fourth machine is often added, styled the "jack" frame. The cotton is fed to the slubber from the drawing-frame cans, whilst it is fed to the other machines from creel bobbins. In other respects the chief difference between one machine and another of the series consists in the increased size, strength, and weight of the parts of the earlier machines as compared with the later. The spindles of the slubber may be $\frac{1}{16}$ th of an inch diam., and those of the roving $\frac{1}{16}$ ths of an inch diam., and the lifts of the bobbins 10 inches and 7 inches respectively. The diameter of the full bobbin from the roving may be about 4 inches, whereas that from the slubbing may be nearly

6 inches. From this it is clear that the slubber will contain less spindles than the roving, say, 85 or 90 for the slubber, and 160 or 165 for the roving. The revolutions of the spindle may reach 620 per minute or so for the slubber, and 1,080 or so for the roving frame.

	Spindles,	Revols,	Lift.	Dia. Full Bobbin.
Intermediate Sizes ...	120	760	10"	4 $\frac{5}{8}$

The Jack frame does not differ much from the roving excepting the lift is shorter and full bobbin diameter is less, and often the size of the empty bobbin is also less. We have a bigger bobbin at the slubber simply because the thickness and strength of the cotton at this point will allow of it, and in a manner compels us to have it. The same size and weight of a bobbin would be impracticable for the creel of the spinning machine if made at the roving frame. The cotton is at that stage so thin and weak that it would utterly refuse to pull off either the full or the empty bobbins. Bigger the bobbins are for the mule creel and better so long as there is room for them, and they will wind off without the roving breaking.

ELEMENTARY DESCRIPTION OF PARTS OF THE MACHINE, AND EXPLANATION OF TERMS.

In the following description advantage is taken of reduced impressions of Messrs. Brooks and Doxey's large and admirable wall maps for classes as in the case of the draw-frame. The numbers serve the double purpose of indicating to beginners the part described and also the approximate sizes of the wheels, etc. In this description when the number of figure is not specially mentioned, reference is always made to figures which are numbered alike. Although the roving frame is more particularly referred to, the same description will serve for all the machines.

FAST AND LOOSE PULLEYS $13" \times 3\frac{3}{4}"$

These are fixed on the outer end of the jack shaft and are connected to the line shaft by a belt.

FLY WHEEL.

This helps to balance and steady the machine and is very useful for turning the machine a little by hand, whenever it is required to do so. It is placed next to the fast and loose pulleys, outside the framing

SPINDLE WHEELS.

A wheel of 65 teeth inside the frame end and fixed on the frame shaft drives by means of the large carrier wheel 98, the wheels on the ends of the spindle shafts 42. There are two of these spindle shafts and they extend the whole length of the frame. Upon them are bevel wheels 50 fastened with set screws. There is one of these wheels to each spindle, and each wheel drives a lesser bevel 24, fastened upon the bottom of the spindles. The two spindle shafts revolve in opposite directions and in order to have the spindles in one row revolving the same way as the other row, the two rows of spindles are placed on opposite sides of their respective spindle shafts. See Fig. 20.

SWING.

The wheel 65 placed next on jack shaft to the 65 spindle driving wheel, and is compounded with the loose bevel wheel 35 in the differential motion and is the first wheel in the series termed the swing. This name is given because the other wheels of the series have a continual oscillatory or swinging motion as well as a rotary motion and because the carrier wheel is sustained in a swing frame.

JACK-1' TH-BOX.

This, in some cases, consists of five bevels, whilst in other cases the largest wheel of the series is a spur wheel. The wheel (35) next to the twist wheel is fast to the shaft. The wheel (35) on the left hand in Fig. 19 is loose on the shaft, and is compounded with the 65. The sun wheel (100) is loose on the shaft and carries with it the two cross carrier wheels (35). It is driven always from the cone drums, but sometimes bevel wheels are used in lieu of straight spur wheels.

TWIST WHEEL.

This wheel is at the extreme inner end of the Jack shaft, and may contain from 45 to 51 teeth commonly. It is the most important wheel on the frame, and drives, by means of a carrier (52), a 50 on the centre of the top cone shaft. A change in number of teeth of this wheel affects a number of things about the frame.

We may here note that we have now referred to all wheels on the main shaft.

TOP CONE END WHEEL.

This wheel (65) drives a large wheel (120) on the end of the front iron roller.

IRON ROLLERS.

1", $\frac{7}{8}$ ", 1". The front iron roller drives the back rollers and this latter drives the middle iron rollers. In each row of iron rollers the individual rollers are connected together from one end of the machine to the other. The "square" of one iron roller fits into the "socket" of the next roller. The rollers being joined together the only parts of the connections that show are the round "necks" which are the bearing surfaces and revolve in the roller stands.

IRON ROLLER STANDS.

These are secured firmly to the roller beam and all the drawing rollers rest on them by their "necks," and in these bearings the rollers revolve.

LEATHER ROLLERS.

These rest on the iron rollers and are caused to revolve by frictional contact with the latter, the friction being increased by weights and saddles. The leather rollers are kept in position by caps bars.

ROLLER WHEELS.

These are the front roller wheel 29, crown wheel 95, change pinion 50, and back roller wheel 50 by which the back roller is driven. Also a small wheel 22 on back roller driving through a carrier a small wheel 15 on middle roller.

CONE DRUMS.

The top cone as shown drives the bottom cone by means of a belt. The top cone is concave and the bottom convex. The belt is always on thick part of driving cone and on thin part of driven cone at the commencement of a set of bobbins. It is gradually moved towards the opposite ends of the cones as the bobbins get larger in size. It is the same for a bobbin leading as for a flyer leading frame.

BOBBIN AND FLYER LEADING.

By bobbin leading is meant that the material, as it comes from the rollers, is wound upon the bobbins, owing to the bobbins revolving more quickly than the spindles and flyers. By flyer leading is meant that winding is caused through the flyer revolving more quickly than the bobbin. This difference in surface speeds between flyers

and bobbins must always be about equal to the uniform delivery of roving by the rollers, and it must be understood that it is always the bobbins which vary, and never in any case the spindles or flyers.

BOTTOM CONE WHEEL 18 TO 20.

This drives the top cross shaft, and thereby the sun wheel. It is a change wheel, useful for getting winding and traverse correct for empty bobbins. It is connected, as shown in diagram, to the sun wheel by wheels 64, 68, 16, 100, and in the same connection the strike wheels 76 are driven by the train of wheels 24, 18 to 20, 26, 40, 22 to 26.

JACK WHEEL 16.

This drives the sun wheel, and may be altered if the winding is not right for diameter of empty bobbin.

SMALL STRIKE WHEEL AND REVERSING BEVELS.

The reversing bevels 76 are first one and then the other in gear with the strike wheel 22 to 26. The consequence is that the reversing wheel shaft upon which they are placed is made to revolve first one way and then the other. The small strike wheel is at the bottom of the upright, and on some frames the wheel on top of upright gears directly into the bevel sun wheel,

LIFTER SHAFT TRAIN OF WHEELS.

There are six of these wheels on this frame. The first is on the reversing wheel shaft and the last is on the lifter shaft. In the figure, the second shaft from the bottom is the reversing wheel shaft, and the next higher up is the lifter shaft. The wheels are 13 on strike shaft, driving a 52 and 53 compound wheel on same stud. The 33 drives a 52 and 22 on same stud. The 22 drives an 80.

LIFTER SHAFT AND RACKS.

By above connection the lifter shaft is caused to revolve first one way and then the other. Small lifter wheels (15) are placed at intervals on the shaft and gear into racks connected to the lifter rail. The teeth in the racks are $\frac{3}{8}$ ths inch pitch. As the shaft revolves the lifter rail is thereby impelled upwards and downwards in turn.

LIFTER RAIL.

This, with its connections, is a ponderous and important part of the frame. It carries the bobbin, shafts and wheels, and therefore the bobbins upwards and downwards, whilst at the same time it allows them full liberty to revolve on their bearings. It has side and top covers to keep the wheels and shafts covered. At one end of it is the swing, which—whilst giving motion to the bobbin shafts—partakes of the oscillatory movement of the lifter rail. The lifter and the bobbin shafts are generally in three parts, properly coupled together.

BALANCE WEIGHTS.

Heavy balance weights are connected to the lifter shaft by chains in such a manner as to counterbalance the weight of the lifter rail and shafts, &c. There is generally one weight to each small lifter wheel and lifter rack. They act on the same principle as the balance weight of a hoist. A preponderance of weight should rest either with the lifter or the weights, so as to prevent backlash on the racks and pinions at the change.

INDICATORS.

These are usually connected to the front iron roller. They automatically register the number of hanks produced per week per spindle, and from their registration the

frame tender's wages are calculated weekly. Figures and complete explanations are given later on in this treatise.

ROLLER BEAM.

This is a very substantial and heavy fixing, which extends the whole length of the frame. It rests on the frame ends, and on intermediate bearings placed several feet from each other the whole length of the frame. The roller stands are firmly secured to the roller beam. As much as 2000lbs of total weight often pull down at the roller beam, irrespective of the weight of the rollers themselves and the roller stands. It is generally in three parts.

SPINDLES.

The spindles have two bearings. The bottom one is termed the footstep. The top bearing is formed by a collar or bolster on the lifter rail.

LONG COLLARS V. SHORT COLLARS.

Long collars extend up the spindle considerably and go inside the empty bobbin. Short collars do not go inside the bobbin at all, and give a shorter bearing for the spindle to revolve in. Long collars tend to give a steadier revolution to the spindles, but are more costly than short collars.

FLATS.

These rest on the top of the leather rollers, and help to keep the latter free from accumulations of fly and dirt.

FULL BOBBIN STOP MOTIONS.

By these motions the frame is automatically stopped when a sufficient length of material has been placed on

the bobbins. Some of these so operate as to make it impossible to start the frame until it has been doffed.

CORDS.

Unlike the mule, cords are practically absent from the fly-frames. There is simply a thin cord with a weight at the end for moving cone drum rack when the escapement takes place.

STOP ROD.

This extends the whole length of the frame and has projecting arms by which the frame can be easily stopped at any time, and from any part of the frame, at the front, and on the slubbing frame either from the back or the front.

SPRINGS.

As with cords, there are few of these about a frame. Probably the only two are found at the cradles of the change motion, or there may be one in connection with the roller traverse.

CREELS.

These are made to hold the bobbins from the preceding machine in a vertical position. The material is drawn from them by the back drawing rollers. The bobbins are placed on skewers, which are fitted in apertures and steps made in the creel. There are usually three rows of bobbins at back and one at front of the frame.

ROLLER TRAVIS.

The rovings are made to travel about sideways a little, in order to prevent wear to the leather, circumferentially, owing to the rovings working too long at one place on the roller.

SPRING PIECES.

These help to carry the roller beam, the lifter shaft, the guide pulleys for the balance weights, and the various shafts necessary for the cone drum, rack motion, etc.

DUPLEX DRIVING.

This is a very recent improvement. It consists of making the top and bottom cone shafts much longer than usual and placing upon them two top and two bottom cones. By this means we have two narrow cone drum straps instead of one comparatively broad strap.

FLYERS.

These are attached to the tops of the spindles. A pin in the flyer top fits into a slit in the apex of the spindle. One leg of the flyer is usually solid and the other tubular. The tubular leg has a presser attached to it, as it were, by a rod or hook. Formerly flyers with a presser on either leg were much in use, but they are now almost extinct.

PRESSER.

The presser is attached to the top and bottom of the tubular leg of the flyer in such a manner as to allow it to oscillate freely on the points of connection. The finger of the presser reaches out at the bottom to the centre of the bobbin whether full or empty. The pressure finger serves two important objects simultaneously. It helps materially to guide the roving upon the bobbin in the first place. Its second and even more important duty is to make a harder bobbin without damaging the material. By the rapid revolution of the flyers a centripetal force is set up which keeps the flattened finger pressing continually against the bobbins. In bobbin leading frames the finger extends to the left hand, or it is in advance of the flyer leg to which

it is attached. In flyer leading frames the finger extends to the right hand, or it is, so to speak, dragging behind the leg to which it is attached. The weighted or leg part of the presser has a centrifugal action and assists in compelling the presser finger to have a centripetal action.

CHANGE MOTION.

This is also called the "Box of bricks." "The ratchet motion." "The building motion, &c." Its functions are to regulate the length of lift all through the set, so as to give a proper cone to each end of the bobbin. Also to accommodate the rate of winding on to the increased diameter of the bobbins at every change of lift. Also to put the reversing wheels in and out of gear. It is somewhat intricate in all its parts and duties. A complete knowledge of the building motion is of much greater value to a practical man than a knowledge of the differential motion problems and such things as the "concave and convex problems."

THE RATCHET WHEEL

(20 to 27) regulates extent of movement of cone belt at every change of the lifter, and is changed to a larger for finer numbers.

CONE-BELT RACK.

This is driven by a 30, and is $\frac{3}{8}$ inch pitch. As shown to right of figure, the 30 is on an upright shaft, which has a 26 bevel on its bottom end, driven by a 30 in change motion.

HANGER-BAR OR ROUND RACK.

This is $\frac{1}{4}$ inch pitch, and is driven by a 20 in change motion. It passes through two snugs in the upper cradle of the change motion at one end, and at the other end it is swivelled on a stud in the double slide of the lifter.

CHAPTER IV.

WINDING PROBLEMS & CONNECTIONS.

HOW WINDING IS ACCOMPLISHED.

In performing his duties as a teacher, the author has frequently been struck with the number of students who never seem to thoroughly grasp the elementary principle of how winding is accomplished on the bobbin and fly frame, quite apart from the mechanism necessary for giving motion to the various parts. Intricate as the mule is, it is quite clear to the merest tyro that the yarn is made during the outward traverse of the carriage, and it is wound on during the inward traverse. On the bobbin and fly frame these operations are being carried on simultaneously, and probably most individuals would be unable to see the principle of winding by simply standing and watching the frame a little. Apart from the mechanism, this principle is certainly more difficult to comprehend on these frames than on the mule. All students ought to thoroughly grasp this winding principle before pondering upon such things as bobbin and flyer leading, the action of the cone drums, the differential motion, etc.

The author feels compelled to speak somewhat strongly upon this point, because he has repeatedly seen students completely lost in some lessons and discussions simply from having an imperfect comprehension of this elementary but fundamental principle.

We will therefore deal with this point first. In all cases winding is accomplished by the circumferential speeds of the bobbin and of the eye of the pressure finger being one greater than the other. Whether the bobbin or flyer lead, these two always revolve in the same direction. They are, so to speak, having a race round, in which one has a start or lead of the other. Whether it be bobbin or flyer lead, this start or lead is always diminished as the bobbins get bigger—that is to say, it is diminished in one sense yet not in another. The number of revolutions per minute that one makes more than the other is always lessened, but the number of circumferential inches that one makes more than the other remains constant all through the set. Winding is not accomplished simply because the bobbins or the flyers make one of them a greater number of revolutions than the other, but because if, say, 500 inches are delivered from the rollers per minute, then the eye of the pressure finger will travel round 500 inches more, or 500 inches less, as the case may be, than the surface of the bobbin, in the same time. This is so at any diameter of the bobbin. Let it be clearly understood, therefore, that winding is accomplished by the difference in these circumferential speeds. The bobbin always bring the varying factor while the flyer or spindle is always a constant factor. To illustrate this more clearly and graphically: take an ordinary bobbin of thread in the left hand, with some of the thread unwound. Take hold of the loose thread with the right hand and wrap it round the bobbin. Now begin to turn the bobbin slowly round, all the time proceeding to wrap the loose thread on it. If the right hand moves more quickly round than the left the thread will still be wound on, although both bobbin and loose thread are being turned round in the same direction.

This is exactly the action of a flyer-leading frame. The right hand may represent the flyer, and the loose thread the

roving as it issues from the rollers. In this case the roving is *wrapped* on the bobbin.

Again, take the bobbin in the right hand whilst the thread is held in the left hand. If the bobbin be revolved the thread will be wound upon it. This winding on will still take place if the hand holding the thread be moved at the same time round with the bobbin, and yet the thread be held loosely—that is, if the bobbin be moved round more quickly than the thread. This is exactly the case of a bobbin-leading frame. The material is in this case *drawn* on to the bobbin by the excess surface speed of the latter over that of the pressure finger. These illustrations are more effective when practically used by a teacher in front of a class than they appear on paper.

The bobbins would not need to revolve at all if it were not that they gradually increase in diameter from the commencement of the set to the finish. The difference in the surface speeds of the two has, therefore, to remain constant in either case, and to produce this equal difference at all parts of the set we are compelled to vary the number of revolutions that the bobbins make all through the set. There is always the greatest difference between the revolutions of bobbin and flyer at the commencement of the set, and the least difference at the finish of the set. In flyer-leading frames the bobbins revolve most rapidly at the finish of set, and in bobbin leading frames the bobbins revolve most rapidly at the commencement of set.

BOBBIN v. FLYER-LEADING FRAMES.

As regards flyer leading frames having the bobbin to revolve most quickly in top of set, the writer was well acquainted with two old and experienced carders, who, some years ago, debated this point to such a degree that it led to betting. One said the highest speed of bobbins was attained at the finish, and the other at the

commencement of the set. Ten shillings were deposited by each man, and a letter was written to Messrs. Platt's machine shop for that firm to give judgment. It is needless to say which won. The incident is simply mentioned to illustrate the improvement technical instruction has brought about within the last few years. At the present time quite a number of young students could be found in almost any Lancashire spinning town who could readily answer the above question.

As to which is best, whether flyer or bobbin leading, it is very probable that, on the whole, bobbin leading is the better of the two. It is certainly much more in favour at the present time than flyer leading. One strong point in favour of this practice is that, when an end breaks in a bobbin-leading frame, the revolution of the bobbin before the frame is stopped tends to keep the broken end on the bobbin in its place. On the flyer-leading frame, if an end breaks the revolution of the bobbin tends to make the loose end unwind and fly about. This is because in a flyer-leading frame the cotton is always wound on the bobbin the contrary way to the winding on of a bobbin in a bobbin-leading frame. This evil is worse in the slubbing than in the roving frame, because of the greater thickness of the cotton in the former machine.

A point which is somewhat in favour of the flyer-leading frame is that the wheels connecting the sun wheel and the bobbins have to revolve more quickly in bobbin-leading frames than in flyer-leading. These include the compound bobbin wheel on the main shaft, the wheels belonging to the "swing," the bobbin shaft bevels, and the small bobbin wheels. It goes without saying that higher speeds do not conduce to longer life of the wheels.

A point which has been made a great deal of by some writers is that in flyer-leading frames a slight stretching of the roving takes place every time the frame is started. There is, no doubt, some weight in this objection, but,

in the opinion of the writer, not as much as some people think and say. It is a curious fact that two or three recent writers state that this effect is produced because the bobbins are driven by a combination of gearing, which includes the cone drums. As a matter of fact the duty of the cone drums is not to drive the bobbins, but to vary the speed of the latter. It is impossible, in the author's opinion, that the connection of the bobbins to the cone drums could produce the evil under discussion. If, as is inferred, the cone drum belt slips ever so little when the frame is started, then, whether the frame be flyer or bobbin-leading, the very opposite effect would result therefrom, *i.e.*, the ends would be slackened instead of tightened. This, of course, is the effect produced by slippage of cone belt alone. The writer first pointed this out in discussion in the *Cotton Factory Times* several years ago, and at the same time he called attention to the fact that when the bottom cone was lifted up, as in doffing, the ends immediately went slack. There is much more foundation in the reason given by some other writers for this stretching of the roving when the frame starts, *viz.*, that it is because there are more wheels in the train that drives the bobbins, than in the train that drives the spindles. There are five wheels involved in driving the spindles. Counting only one of the Bevel carriers in the "Jack-i'th'-box," there are nine involved in driving the bobbins. There will thus be considerably more backlash in the bobbin wheels than in the spindle wheels every time the frame is started. This will tend to slacken the ends when starting a bobbin leading frame, and stretch them in a flyer-leading frame. There is another point, however, which tends somewhat to mitigate this stretching in a flyer-leading frame, and which seems to have been overlooked. There are generally five or six wheels, counting from the bottom cone wheel to the sun wheel, and any backlash in these tends to act with the slippage of the cone

belt in mitigating the stretching of the rove caused by backlash in the nine wheels before mentioned. It would seem, indeed, at first sight, that these losses, combined with the loss in the spindle-driving train of wheels, would quite counteract and balance the backlash in the nine bobbin wheels. This is, perhaps, scarcely so, because the wheels from the cone drum to the sun wheel have only a secondary and reduced effect on the bobbins. However, with good gearing, if the roving gets no more stretching and thin places than what are caused by this evil, there will be little room for complaint. Be that as it may, there are scores of flyer-leading frames at work in different places, and the yarn that is finally produced from the roving is second to none of its class. At some mills which contained many flyer-leading frames and a few bobbin leading frames, the latter have been discarded. Not, however, because they did not make good bobbins, but because of the inconvenience of having two sorts of frames and the difficulty of keeping good tenters on the bobbin-leading frames. The difference between a right hand and a left hand frame probably affects the tenter more than anyone else. On the whole, the author may sum up by saying that in his opinion, all conditions being equal, the bobbin leading is the better of the two, but not to the extent that many people seem to think. The subject is certainly an important and practical one, and quite deserves lengthy discussion. An evil of bobbin leading, which we almost forgot to mention, is that the sun wheel, with its two carriers, have to revolve in contrary direction to the frame shaft upon which they are placed. This generates an amount of friction which adds to the work of the cone-drum belt, and in some cases the sun wheel is now made to revolve on a long collar or bush. In flyer leading, the sun wheel revolves the same way as the shaft. To obviate these defects of bobbin-leading frames, several new differential motions have been invented, which will be referred

to later on. In bobbin leading also, all the bobbin driving wheels have to revolve faster than in flyer leading, and in some cases the sun wheel is now made to revolve on a long collar on bush.

BROKEN SLUBBING ENDS FLYING LOOSE.

A short time since the writer stood at the en of a flyer leading slubbing, upon which an end had just broken, and, for the sake of experiment, the tenter was directed to let it alone for a few minutes. Immediately the loose stuff issuing from the rollers became entangled with adjoining end. At the same time the loose end from the slubbing bobbin began to fly about and unrove, so as to break down the next end. One end rapidly broke another down, so that the combined effect of all the ends unroving from the bobbing, and all the loose cotton coming from the rollers, in about ten minutes had caused the breakage of between twenty and thirty slubbing ends. All the frame was covered with fly, and the bobbins, where the ends had broken, were spoiled. Of course, this is well known to be one of the first defects of the flyer leading system. In a bobbin leading frame, although the cotton issuing from the rollers would either form a roller lap or fly loose, it would not of itself do very much damage, and the revolution of the bobbin would tend to keep its broken end in its own place instead of unroving, as in the flyer leading frame. In the instance just cited, it was a Saturday, and the tenter had just cleaned her frame, but she had to begin again, and spent about ten minutes in hurriedly cleaning the roller beam, the flyers, the lifter, the floor, etc., of the loose fly, in addition to piecing the broken ends.

In a lecture delivered by the writer at Royton, in September of 1895, he said a few words in favour of flyer leading. Certainly, however, he did not go to the length

which it has been assumed he did by some practical men. Since that time a well-known Oldham mill manager and cotton teacher told the writer that a widespread belief existed in Oldham, that in the Royton lecture he had definitely stated that if he were now putting up a new spinning mill he would fill it with flyer leading frames. This is exactly opposite to what was really said. The writer protested against the wholesale condemnation of the flyer leading system, and said that he would hesitate to spend money in converting good running flyer leading frames that were giving as good results as any bobbin leading frames that could be found. To take one particular instance—Mr. Thomas Ashton, the secretary of the Oldham Operative Spinners, had occasion to pay a visit to a certain mill outside the Oldham district, in 1893, at which the writer was employed, with reference to a dispute that existed concerning some old mules. Mr. Ashton examined the twist yarn at the mill, and incidentally remarked that it was a much better twist than the average spun in Oldham. Now all the frames at this mill have the flyer leading, and it is well known that the cloth produced from their yarn is of first-rate quality. Such instances of actual practice, as the one just quoted, could scarcely exist if the roving on flyer leading frames were strained to the great and universal extent that some people contend it is.

This subject of flyer *versus* bobbin leading has been a matter of difference of opinion ever since bobbin and flyer frames were successfully introduced, and for a great number of years the flyer leading system was by far the more commonly adopted. It is well known, however, that at the present time bobbin leading is much more popular.

HOLDSWORTH'S JACK-IN-THE-BOX.

It is perhaps advisable that a description of this motion be given at this stage.

It is somewhat difficult to obtain a thorough comprehension of the exact duties and operation of each part of this ingenious and useful piece of mechanism.

It may be said further, that a thorough knowledge of its admirable and complex operations is much more interesting than practically useful.

The author knows a large number of good, practical men in charge of frames who would find it utterly impossible to explain the workings of the differential motion thoroughly; yet they make excellent carders and frame overlookers. The fact is, they can perform their practical adjustments quite readily without such a knowledge. Take these men, however, to the "Building motion" and they will explain the most minute details respecting it. They are compelled to have such ability. This fact is mentioned because the author holds a very strong opinion that less attention ought to be devoted to the differential motion at the classes and examinations and more to the "Building motion." Also, it is given as a hint to young overlookers first to master the intricacies of the latter motion, and then by all means direct their attention to the differential motion. In these days of technical education, of course, every practical man ought to get a knowledge of the theories as well as the practice of his machines.

The differential mechanism is divided into two distinct parts and motions, each of which does its own work, and yet is, in actual practice, inseparably mixed up with and connected with the other.

Referring to the lecture diagram, **A** is the sun wheel, **B** the nearest wheel of the series to the twist wheel, and the only wheel of the series that is secured to the jack shaft. **C** and **D** are carrier wheels, which have their bearings in the sun wheel arms. **E** is the driven wheel of the series and is compounded with **F**, which is the first of the train of wheels belonging to the "Swing." As before said, the motion consists of two distinct parts. In the

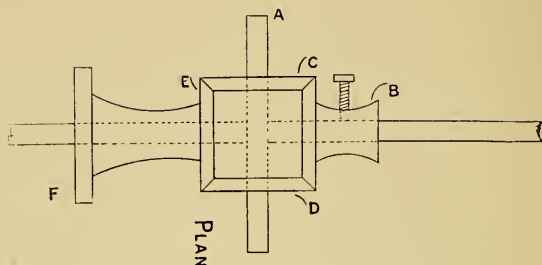


FIG. 21.

first place, as the wheel **B** is secured to the shaft it revolves with it, and because **B**, **C**, and **E** are geared together and are equal in size, **E** is compelled to move at the same speed as **B**, but in the opposite direction. As **D** is simply a balance wheel, we can leave it out of the description altogether. Supposing the sun wheel **A** to be stationary, (although, it never is in actual working) there is little difficulty in understanding, therefore, the exact duty of **B**. It will revolve **E**, and, consequently, **F** at the same speed as itself, but in the opposite direction. This is the first part of the differential motion, and it ought to be thoroughly comprehended before going any further. It is the non-variable portion of the mechanism, and is the same either for bobbin or flyer-leading. Of itself **B** gives a number of revolutions per minute to the bobbins exactly equal to the number of revolutions of the spindles per minute. If the spindles make 1,000 revolutions per minute, then the bobbins will make 1,000 revolutions per minute if the sun wheel be stationary. This wheel **B** is, therefore, the chief driver of the series. This point requires emphasising, inasmuch as there is a widespread notion that the cone drums are the chief driving factors in the arrangement. In a good number of instances the writer has practically demonstrated this point by actually stopping the sun wheel, and then having students to notice that the

bobbins and spindles went at one speed, and the looks of astonishment have been often amusing to see, at this undeniable evidence.

Now, as a matter of fact, if, say, the spindles of a roving frame make 1,000 revolutions per minute, and 400 inches per minute are delivered from the front roller, then the bobbins in a bobbin leading frame must make something like 1,040 revolutions per minute for the full bobbin, and perhaps 1,100 or more revolutions for the empty bobbin per minute. In each case 1,000 of these revolutions will be given to the bobbins by the fast wheel **B**, leaving about 40 for the full bobbin, and 100 or so for the empty bobbin, to be contributed by the cone drums. In flyer leading the bobbins would make 1,000, less 40 or 100, as the case might be.

This introduces us to the second distinct part of the mechanism of the differential motion. This emanates entirely from the largest wheel of the series, which is termed the sun wheel. This is driven from the cone drums, and is the variable portion of the mechanism. Its duty is, as it were, to interfere with the work done by the fast wheel **B**. In a bobbin-leading frame it adds to the work done by **B**. In a flyer-leading frame it deducts something from the work done by **B**. Every time the sun wheel goes once round it either imparts an additional two revolutions to the loose compound wheel **E F**, or else it takes two revolutions from the latter. If it be a bobbin-leading frame the sun wheel revolves in the same direction as the loose wheel **E**, and gives it additional revolutions to those obtained from the fast wheel **B**. If it be a flyer-leading frame the sun wheel **A** revolves in the opposite direction to the loose wheel **E**, and takes away from the latter some of the revolutions which the fast wheel **B** is attempting to give to it.

It is not at all an easy task to clearly see how it is that one revolution of the sun wheel imparts two revolutions to

the loose bobbin wheel. The method adopted by the author in explaining this point to his own students is perhaps as good as any. For the purposes of illustration, take away the fast wheel **B** and the balance wheel **D** as shown in figure.

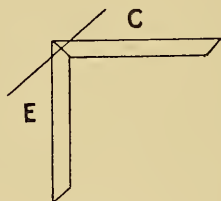


FIG. 22.

Let it be assumed that a pin be driven through **E** and **C**, as shown at **C**, and binding them firmly together. If the sun wheel **A** be revolved it will take **C** with it, and consequently **E**. Therefore **E** and **A** will each make one revolution in the same time. It is thus clearly shown how one revolution of **A** will give one revolution to **E**, because, although in actual practice the wheels **E** **C** are not really pinned together, the very fact of the two being geared together, tooth and tooth, compels one to go with the other, or the teeth will break.

How then does one revolution of sun wheel **A** compel the loose wheel **E** to make a second revolution as well as the one just described? In the sketch just given it is shown that **E**, the loose wheel, would be compelled to revolve once if the carrier wheel **C** did not revolve on its own axis in the arms of the sun wheel. Clearly then, if carrier **C** is made to revolve on its own axis as well as moving round with the sun wheel, an additional effect must be produced on the loose wheel **C**. As a matter of fact, the carrier wheel in actual work is engaged with the fast wheel **B**, and this connection compels the carrier to

revolve once on its own axis to being carried once round with the sun wheel—this is supposing the fast wheel be stationary. One revolution of the sun wheel, therefore, means two revolutions of the loose bobbin wheel. The actual fact is best seen by a glance at an ordinary modern wrap reel, in which the gearing is exactly the same, excepting that the handle takes the place of the balance wheel **D**, and also the fast wheel **B** is stationary. Sometimes this point can be seen best by regarding the carrier wheel as a lever with the fulcrum at the fast wheel, and the driven wheel being twice as far from the fulcrum as the handle is.

The fact that these operations in the differential motion are all taking place at once renders it absolutely impossible to comprehend them by simply watching the apparatus while working. Nevertheless, because they are all operating together, it is none the less true that each is doing its own particular duty, and probably the only way of comprehending this duty in each case is by some such analysis as above given.

In flyer-leading frames, if it were ever possible for the sun wheel **A** to be revolved at half the speed of the fast wheel **B**, then the loose wheel **E F** would stop altogether, and consequently so also would the bobbins. The effect produced by the revolution of the fast wheel **B** would be entirely counteracted by the work done by the sun wheel **A**, revolving contrary to the loose wheel **E F**.

RE-ACTION.

As we have said, if anyone will disconnect the sun wheel from the wheel that drives it, and then have someone to turn the frame by the fly wheel whilst the sun wheel is all the time held stationary by hand, the spindles and bobbins will be found to revolve at the same speed, which is a practical demonstration that the chief motor for the bobbins is the bevel wheel fastened to the main shaft of the frame, and

placed next to the twist wheel. The person who holds the sun wheel, however, will find that there is a tendency for it to revolve, impelled by some force in the differential motion. This is the re-action from the bobbins. They offer a resistance to motion which travels back into the differential motion, and devolves upon the sun wheel and thence upon the cone drum belt. We have demonstrated at length that 1,000 out of less than 1,100 revolutions per minute of the bobbins are derived from the jack shaft, independently of the cone drums. Practically speaking, however, a considerable portion of the power for these 1,000 revolutions, although emanating from the fast wheel, passes through the arms of the sun wheel, and therefore indirectly devolves upon the cone drum belt.

This is more pronounced in bobbin leading than in flyer leading frames. This re-actionary power of the bobbins devolving upon the cone belt, constitutes one of the chief defects of Holdsworth's motion, and is a defect possessed to a less extent by one or two of the new differential motions. The new motions, however, are some of them entirely free from this defect. Reference to the principle of a bevel wheel dynamometer would perhaps explain this feature clearly. This re-action does not turn the cone drum when the belt is disconnected, simply because the resistance of the lifter and cone wheels is greater than the resistance of the bobbins.

It may be said that the differential motion belongs to the epicyclic trains of wheels, and students who desire to go theoretically further into the subject of epicyclic trains will find it minutely discussed in "Goodeve's Elements of Mechanism," pages 222 to 251. Unless, however, a student is very proficient in applied mechanics, he will only become confused by studying it in the abstract and algebraical manner adopted by Professor Goodeve.

CONE DRUMS.

Having shown at length that the revolution of the sun wheel in the "Jack-in-the-box" enables the speed of the bobbins to be accelerated or retarded, as the case may be, just according to the direction in which the sun wheel revolves, and to an extent determined by the speed of the sun wheel, it now devolves upon us to show how the sun wheel itself derives its motion.

We might just mention that the "Jack-in-the-Box" cannot, in one sense, be termed a differential motion of itself, inasmuch as it is of no use without the cone drums to give it a varying speed. If it revolved at one speed all through the set, we should dispense with it altogether.

If the bobbins kept at one diameter, as mule cops do after the thickness is attained, then we could allow the sun wheel to revolve at one speed, just as we allow the quadrant nut to remain stationary on a mule quadrant when the thickness of cop has been reached.

As a matter of fact, however, the bobbins increase in diameter with every layer put on, right from the beginning to the finish of the set of bobbins.

We have, therefore, to revolve the sun wheel at a speed which varies somewhat with every layer put on the bobbins.

In all cases, and whether bobbin or flyer-leading, we start the sun wheel at its highest speed at the commencement of the set, and gradually give a slower revolution to it until the bobbins are full. It would be possible to give a varying speed to the sun wheel in various ways.

The means that are now universally adopted are the provision of a pair of cone drums, which are well suited to the processes of cotton manufacture in more departments than one, notably, in connection with the piano motions of scutchers, and on some makes of "slashing frames" for driving the front beam.

The cone drums not only drive the sun wheel, but also the lifter shaft and rail. This connection enables us to slower the lift every time we slower the rate of winding, which is a very necessary and essential procedure.

The top cone is operated positively from the twist wheel, and is always the driver.

The bottom cone is always driven in a non-positive manner by a belt from the top cone, and we may just notice that this is the greatest defect in the system. Any imperfections in the belt, such as being slack, badly pieced, irregular in width, etc., communicate themselves to the winding. These defects, however, do not show up as strongly with the new differential motions as with Holdsworth's, at any rate with bobbin leading.

The cone drum belt is always at the commencement of a set of bobbins—whether it be bobbin or flyer leading—on the thick end of the top cone, and on the thin end of the bottom or driven cone. As the bobbins increase in diameter, the belt is moved up the bottom cone in a manner which will be afterwards described when dealing with the “building motion.”

The mechanism involved in transmitting the motion of the bottom cone to the sun wheel differs a little in detail with different makes. The principle is, however, the same in all cases. A number of wheels, and one or more short shafts, connect the bottom cone end wheel to the sun wheel, and somewhere between the two wheels a connection is established which drives the reversing bevels for the lifter.

The main advantage that one method may have over another, is that in some makes the different wheels and shafts are more easy of access than in others.

We now propose to give somewhat extended notice to a peculiarity in the construction of the cone drums which at once arrests the attention of even the most superficial observer. We mean the fact that the cones are not

of a straight or uniform taper, *i.e.* they are not right cones, but the top or driving cone is hollow or concave in its length, whilst the bottom or driven cone, bulges outwards, as it were, towards the centre, or is convex in outline.

The two cones are the reverse of each other, or, in other words, one is, so to speak, made hollow to just the same extent as the other is made convex. This is shown in Fig. 23.

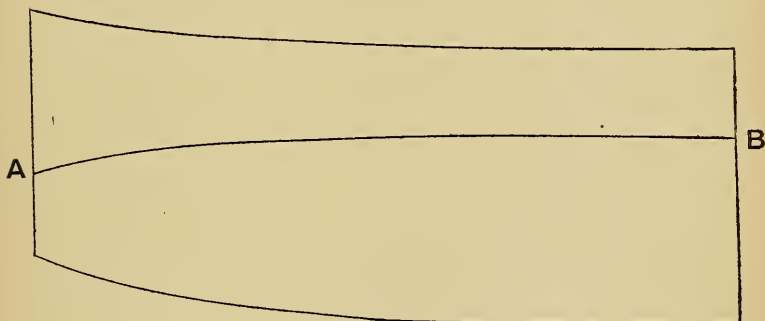


FIG. 23.

The line **A B** will do either for top or bottom cone, just as its concave or convex side may be outside.

Although the necessity for this peculiar configuration has been repeatedly demonstrated by actual experiment, many practical men have strenuously contended that it was unnecessary until they have been convinced by seeing uniform cones tried.

The author knows of at least two cases in which the carders and the masters of spinning mills were both firmly convinced that uniform cones would work all right, and, if anything, with better results even than concave and convex cones. They were so absolutely certain of this that they actually had pairs of uniform cones made and applied to frames. It is almost needless to say that they were soon made sadder and wiser men by the utter failure of their little experiments.

It is now a sufficiently well-established fact that uniform cones will not give the necessary differential motion to the sun wheel, and consequently to the bobbins, with that degree of exactness which the exigencies of the case require. The adjustment of the winding power at every fresh layer put on the bobbin requires to be made so accurately that the least deviation from a proper configuration of the cones, results either in the ends becoming too tight or too slack, as the case may be.

If uniform cones were used then the ends for some time after doffing would be too tight, and if altered, by some means yet they would keep continually getting too tight or too slack all through the set.

WHY ARE CONE DRUMS CONCAVE AND CONVEX?

The explanation of the why and wherefore for the absolute necessity of having cone drums of a concave and convex outline always has been, and is yet, in the minds of a great many students and practical men, surrounded by a considerable degree of perplexity.

It is certain that many reasons have been advanced and suggested in explanation of this fact that are quite wide of the mark. It will be beneficial to examine some of these reasons given, seeing that they are put before us.

FIRST.—THEORY OF CONE-BELT SLIPPAGE.

Some writers have contended that it is due chiefly to the slippage of the cone belt.

It is not improbable that the slippage of the cone-drum belt somewhat increases the necessity for the cone drums being made concave and convex. It is well enough

established that there is a considerable amount of such slippage. If this slippage were equal at all points of the traverse of the belt, it is scarcely likely that the configuration of either of the cones would be at all affected thereby. It is, however, quite within the bounds of possibility that the total amount of slippage of the cone belt is less at the middle of the cones than elsewhere; Also that it is greater when the belt is on the thin end of one of the cones than at other points. We are not asserting positively that such is the case, but only suggesting that it may possibly be so. If such were the case, then the effect upon the cones would, in the author's opinion, tend to make them concave and convex. Take the initial position of the belt upon the thin end of the bottom or driven cone. If there were an excess amount of slippage here, then the loss in speed would be overcome by tapering the bottom cone off a little more abruptly, and thickening the top cone to a corresponding degree.

Take now the the final position of the belt at the thinnest portion of the top cone. It is possible that here there is an extra amount of slippage over the top cone, whereas before it was on the bottom cone. In either case the effect produced is the same, viz., to reduce the speed of the bottom cone unduly. This would again be overcome by reducing diameter of top cone and increasing diameter of bottom cone to a less degree than would otherwise be necessary. It must be distinctly understood that the author is quite of opinion that in any case this slippage has only a minor effect on the configuration of the cones.

The idea is, perhaps, a little strengthened by the fact that absolutely correct outlines for the cones are only established by repeatedly turning and scraping their surfaces. Also, it is well known that if we get below a certain diameter of pulley for a belt to work upon, it appears as if the slippage increased in an undue proportion to the diminution in size of pulley.

SECOND.—THEORY OF SPONGY ROVING.

Several writers have asserted that it is, at any rate, due in part to the soft, spongy nature of the roving that is put on the bobbin. It is alleged that the spongy nature of the material causes the bobbins to swell out and increase in diameter as they get fuller, to an amount in excess of what is due from the mere diameter of each coil of roving itself. As a consequence, if the cones were not made concave and convex, then the ends would be too tight when the cone belt approached the middle of the cones.

Now, if this argument be true, is it not quite clear that this swelling or excess diameter would be most when the bobbins were nearly full? If so, then the bottom cone would have to be swelled out most in diameter at this point. But is this so? Nothing of the kind. As a matter of fact the increase in diameter of the bottom cone for a given portion of its length is less at this point than the increase for the same length at any other portion of the cone. Particularly is this noticeable when the extreme thick end of the cone is compared with the extreme thin end of the bottom cone. It seems clear that this simple comparison effectually disposes of the argument that the sponginess of the roving causes an extra increase in diameter of the bobbin, and thereby compels the cones to be made concave and convex.

THIRD.—UNEQUAL RACK THEORY.

In some instances it has been alleged that the peculiar configuration of the cone drums is a necessity arising from the fact of having an equally divided rack for operating the cone belt. This is an erroneous idea. It is not denied that it would be perhaps possible to have an unequally divided rack that would produce an effect somewhat analogous to what is produced by having the cones

concave and convex. As a matter of fact, in the earlier makes of frames, only one cone was used, and the let-off motion was arranged with a parabolic rack, as shown at the beginning of this book, although it is absolutely certain that this method was not near so effective as the irregularly shaped pair of cones. It is the proper thing, however, to have an equally divided rack, and the very fact that an unequally divided rack has been suggested or tried, only proves that there is some peculiarity existing elsewhere in the frame that has to be compensated or allowed for. What that peculiarity is we hope to show presently.

FOURTH.—THEORY OF EQUAL DIMINUTION OF CONE SPEED.

It has been repeatedly and strenuously urged that if the bottom cone drum lost, say 10 revolutions for an inch traverse of cone belt at beginning of set, then it must necessarily, to ensure correct winding, lose 10 revolutions for every other inch the belt moves, reckoning every inch from one end of the cones to the other. Figures have been given to show that straight cones would not give such regular diminution, and, therefore, concave and convex cones have been used. More credence has been given to this theory than any other. It has received more attention at the hands of writers upon cotton spinning than any other theory. Several good writers have dealt with it to the tune of several pages, and have given copious figures and explanations which have seemed to completely prove their case. This being so, it is essential for our purpose to examine this theory in detail, whether it be correct or not.

It is necessary first to state the case for this argument in order to deal with it effectively. The first thing to do is to prove that in a straight cone, if an inch in length means a certain diminution in diameter—say $\frac{1}{16}$ th of an inch

for instance—then for every other inch in length of the cone towards the thin end there would also be a diminution of $\frac{1}{16}$ th of an inch in diameter. This can easily be proved by algebraical solutions in which the length necessary to bring the thin end of the cone to a point is first obtained, and afterwards from this the diameter of the cone at every necessary position. We can, however, demonstrate this in a graphical manner which will doubtless be simpler to many practical readers. Describe any uniform cone, as Fig. 24; measure off equal portions of length on each side of the cone; draw diameters connecting these points, as **A, B, C, D, E, F**. If now these lines be measured, it will be found that equal traverses of length give equal diminutions in diameter, or going from the thin end towards the thick end of the cone, equal traverses of length give equal increases in diameter.

UNIFORM CONE.

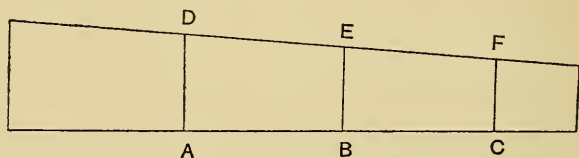


FIG. 24.

Thus, **B** is $\frac{1}{16}$ th of an inch less than **A**, **C** is $\frac{1}{16}$ th of an inch less than **B**, &c. This fact, which is conclusively proved, is the first part of the argument.

It is perfectly obvious that, in order to keep the cone drum belt at a uniform tension, the sum of the diameters of the top and bottom cones must always be the same at whatever point in their length we choose to measure them, or, in other words, for any position of the cone belt. This being so, it follows that, by whatever quantity we diminish the diameter of top cone, we must also increase the

diameter of bottom cone. In the case above given we diminish the top cone by $\frac{1}{8}$ th of an inch at a given point; we must, therefore, increase the diameter of the bottom cone by $\frac{1}{8}$ th of an inch.

Now, the speed of the top cone is a fixed quantity, and if we obtain by the above or any other method the diameters of the two cones at any point, we can, by a simple application of the rule for speeds, determine the revolutions of the bottom cone at that point. We will assume that we have a pair of uniform cones which are 8 inches diameter at the thick ends and 4 inches diameter at the thin ends, and that the speed of the top cone be 200 per minute, and also that for every inch of traverse of the cone belt the diameter of the top cone diminishes by $\frac{1}{8}$ th of an inch, and the diameter of the bottom increases by a like quantity.

From these figures we can easily obtain the speed of the bottom cone for any position of the belt on the cones. This is shown below for the first four positions, nothing being allowed for slippage of belt :—

$$\begin{array}{rcl}
 \text{(1) } 200 \times 8 & & \\
 \hline
 & & = 400 \\
 & 4 & \\
 \text{(2) } 200 \times 7\frac{7}{8} & & \\
 \hline
 & & = 381\cdot81 \\
 & 4\frac{1}{8} & \\
 \text{(3) } 200 \times 7\frac{3}{4} & & \\
 \hline
 & & = 364\cdot70 \\
 & 4\frac{1}{4} & \\
 \text{(4) } 200 \times 7\frac{5}{8} & & \\
 \hline
 & & = 348\cdot57 \\
 & 4\frac{3}{8} &
 \end{array}$$

We have now to subtract these answers one from another in succession.

$$\begin{array}{rcl}
 400 - 381\cdot81 & = & 18\cdot19 \text{ (A)} \\
 381\cdot81 - 364\cdot70 & = & 17\cdot11 \text{ (B)} \\
 364\cdot70 - 348\cdot57 & = & 16\cdot13 \text{ (C)}
 \end{array}$$

The all important point we have to notice is, that **A**, **B** and **C** are not equal to one another. For the first inch movement of cone belt we lose 18·19 revolutions. For the second inch movement of cone belt we only lose 17·11 revolutions, while, as shown, the third inch movement gives an even less reduction. The above solutions could be continued for as many inch movements of the cone belt as we liked, and would always show the same unequal diminution. There is absolutely no denying this fact.

But now comes the crucial point. Having demonstrated, although in another way, this unequal diminution of speed of bottom cone, the supporters of the theory under discussion assert in unmistakable and unqualified terms, that such irregular reduction of speed is quite inadmissible. They say, in fact, that if 18·19 revolutions are lost by the bottom cone for the first inch movement of the belt, then 18·19 revolutions must be lost for every other inch movement of the belt, no more and no less. They say, therefore, that the reason for making the cones concave and convex is to get this regular diminution.

This view of the matter the author is quite unable to take. He gives it, as his absolute belief, that no such regular and equal diminution is necessary or practicable. One or two reasons for this view of the matter may be given. In the first place, the assertions that the cones are made concave and convex to obtain a uniform diminution of speed can only spring from an imperfect comprehension of the true outline of such cones. Take the bottom or convex cone: it may be stated as a fact that does not appear to be sufficiently well understood, that the increase in diameter of this cone for the first inch movement of the cone belt is more than the increase in diameter for the next inch movement. In the same way the increase in diameter for the second inch is more than the increase for the third inch; and so on right to the other end of any convex cone. Almost all students seem to imagine that

the swelling out or increase in diameter of the bottom cone is most in the centre. This idea is erroneous. The swelling out is more at the extreme thin end of the bottom cone for a given length of the cone, than it is for the same given length at any other position.

This fact being thoroughly understood, it will be seen that making the cones concave and convex, instead of making the diminutions in speed equal, compels them to be still more unequal. With such cones, if the increase in diameter of bottom cone be $\frac{1}{8}$ th inch for first inch movement of belt, then the increase in diameter for the second inch movement of belt would be something less than $\frac{1}{8}$ th inch. If, therefore, the diameters given by concave and convex drums be applied to such calculations as above given, it will be found that the final answers **A, B, C**, obtained as by above methods, show an even greater difference than they now do.

We have thus shown that if regular diminutions of speed were the desideratum to be aimed at, the present concave and convex structure of the cones would only make matters worse.

We may now go a step further. We have to assert that not only will these seemingly unequal diminutions of speed be given by both right cones and concave and convex cones, but also that they are absolutely necessary, and constitute a fundamental principle of cone drums wherever applied to any similar purpose, *i.e.*, to give differential speeds in order to accommodate varying diameters. One or two simple illustrations will, we think, demonstrate this fact clearly. Assume that the bottom cone makes 400 revolutions per minute with the belt at the thin end, and 100 revolutions per minute with the belt at the thick end, which difference would represent somewhere about what exists in actual practice.

Following up the theory under discussion, *viz.*, that we deduct an equal number from revolutions of bottom

cone for an inch movement of cone-belt at any point of the traverse, we will assume that this equal number be 10. After the first inch of movement of belt, therefore, the speed of bottom cone would be $400 - 10 = 390$. When the belt was at the other end of the cones, and it then moved an inch, we should deduct 10 from $100 = 90$. Now, here is the point. This seeming equality is really a vast inequality. Where speeds of pulleys are concerned we do not use addition and subtraction, but multiplication and division. Ten from 400 means a reduction in speed of only $\frac{1}{40}$ th part of the whole, whilst 10 from 100 means a reduction of $\frac{1}{10}$ th part of the whole. The seeming equalities would mean a reduction of speed at the thick end of bottom cone, when the bobbins were full, which would be four times as great as the reduction at the thin end of driven cone when the bobbins were empty.

This is on the same principle as reducing a vulgar fraction to lower terms. Take $\frac{1}{4}\frac{0}{0}$ for instance. If we divide each term by 10 we get $\frac{1}{4}\frac{0}{0}$, which leaves the two fractions to be equal. If we subtracted 10 from each term we should obtain $\frac{9}{3}\frac{0}{0}$, which is a different value.

A better and more practical illustration, even than the above may be given. It needs little reasoning to see that if the speed of the bottom cone be reduced 10 revolutions in a given time, or for any one inch of traverse of cone belt, it will always mean that the speed of the bobbins is varied by one certain number of revolutions. We will say that 10 revolutions of bottom cone are equal to a variation of two revolutions in the speed of the bobbins, whatever diameter the bobbins themselves may be. Let the circumference of the empty bobbin be four inches, and circumference of full bobbin be 12 inches, in a bobbin-leading frame. Clearly, now, two revolutions reduction in speed of empty bobbin would ease the winding to the extent only of $4 \times 2 = 8$ inches; whereas two revolutions reduction in speed of full bobbin would ease the winding to the

extent of 24 inches. Where, now, is the theory of equal diminutions? We have assumed extreme speeds of bottom cone to be 400 and 100. There is here shown a total loss of 300 revolutions, which would mean cones of 30 inches length, allowing a uniform reduction of 10 revolutions for every inch traverse of cone belt. We should say, however, without going into figures, that a loss of four or five revolutions at the completion of set, and 15 or 16 at beginning of set would, in this case, be much nearer the mark for an inch traverse of cone belt.

Without going into any further proofs or figures on this point, if these already given be correct, it is clear that this theory of seemingly equal diminutions, which has been accepted by most of our leading authorities for many years, is absolutely wide of the mark, and misleading.

Before leaving this subject, it remains for us to point out that the authorities in question, having, as they think, well established the principle that the necessity for having concave and convex drums is caused by uniform cones giving unequal diminutions in speed, proceed to lay down at some length a method of obtaining the true outline of the cones, which is absolutely dependent upon uniform reductions in speed.

We need not examine this method, simply because if, as we have been attempting to prove, these so-called uniform reductions are absolutely unpracticable, then the method of shaping the cones, based upon a false principle, must also be an incorrect one. Clearly a method which takes, as a basis, that 10 revolutions loss in speed of bottom cone for empty bobbins have exactly the same effect on the winding as 10 revolutions loss of bottom cone speed for full bobbin, must be unsound.

AUTHOR'S THEORY OF CONCAVE AND CONVEX.

We have now to offer what we deem to be a correct solution of the problem.

Why are the cones concave and convex ?

Now, as the chief function of the cone drums is to regulate the speed of the bobbins according to the gradual increase in diameter of the latter, it is the author's opinion that the varying diameter of the bobbin is the only true basis upon which to establish a theory regarding the peculiar configuration of the cones.

Also, it is the only true basis upon which to establish a method of describing a correct outline for the cones.

Upon the varying diameter of the bobbin then all our explanations and suggestions will be based. We will assume for our purpose the following particulars:—

Diameter of empty bobbin $1\frac{1}{4}$ inches. Diameter of bobbin when full $3\frac{7}{8}$ inches. Revolutions of bottom cone for empty bobbin 400 per minute. Revolutions of bottom cone for the $3\frac{7}{8}$ inches diameter of bobbin 100 per minute.

Now, suppose we increase diameter of empty bobbin and also of full bobbin by $\frac{1}{8}$ th inch. Connecting the diameter of the bobbin to the speed of bottom cone, we might easily at first imagine that the revolutions of the latter would require to be diminished by $\frac{1}{8}$ th of the total in each case. It would be very natural to do this, and we should obtain thereby reductions in speed as follows:—

$$(1) \quad \frac{400}{8} = 50$$

$$(2) \quad \frac{100}{8} = 12.5$$

By this method, therefore, we should reduce revolutions of bottom cone for the $\frac{1}{8}$ th inch increase to empty bobbin by 50, and revolutions of same cone for $\frac{1}{8}$ th increase to full bobbin by 12.5. Of course, as we have before pointed out, this 12.5 decrease for full bobbin would produce about the same effect on the winding as the 50 revolutions decrease for empty bobbins. This is simply because a reduction of one revolution in speed of full bobbin

produces about four times the effect of a reduction of one revolution in speed of empty bobbin.

Now, if we were to begin with the empty bobbin, and gradually reduce the speed of bottom cone by $\frac{1}{8}$ th every time we added $\frac{1}{8}$ th inch to the diameter of the bobbin until the latter was full, we should obtain a series of figures from which we might deduce the diameters of the cones at each point. But, let it be especially noted, these cones would be of a uniform outline, and not concave and convex. They would be straight cones.

We have now come to the all-important line or two of words which will, we think, reveal to us clearly the reason why the cones are compelled to be concave and convex.

Take exactly the same particulars as given above. Assume, as before, that $\frac{1}{8}$ th of an inch be added to the diameter of full and empty bobbins. Both are increased by a fixed and equal quantity; but the increase of $\frac{1}{8}$ th of an inch to the empty bobbin is $\frac{1}{10}$ th of its total diameter, whilst the increase of $\frac{1}{8}$ th of an inch to the full bobbin is only $\frac{1}{31}$ st part of its total diameter.

The revolutions of the bottom cone, and consequently, the configuration of the cones, are compelled to be ruled by this proportional increase of diameter to the bobbins, and not by the fixed and uniform increase of $\frac{1}{8}$ th of an inch. If we doubled the diameter of the bobbin we should be compelled to halve the speed of the bottom cone and the sun wheel in order to halve those revolutions of the bobbin which represent the winding, *i.e.*, the excess over the spindle revolutions. It does not matter whether we add an inch, or two inches, or any fixed quantity, to the bobbin diameter to make it twice as thick, the fixed quantity has nothing to do with the problem.

Every $\frac{1}{8}$ th of an inch we add to the diameter of the bobbin from empty bobbin to full bobbin bears a less proportion to the total diameter than the preceding $\frac{1}{8}$ th of an inch.

Because of this fact we are compelled to increase the diameter of the bottom cone by a less amount for the addition of the second $\frac{1}{8}$ th inch to bobbin diameter than for the first $\frac{1}{8}$ th inch. The third $\frac{1}{8}$ th inch added to the bobbin would require a less amount adding to bottom cone diameter than the second $\frac{1}{8}$ th inch, and so on, *ad infinitum*.

In the above case we have to speed the bottom cone by $\frac{1}{10}$ th of its total revolutions for the $\frac{1}{8}$ th inch added to diameter of empty bobbins. This gives us

$$\frac{400}{10} = 40^{\text{revs.}} \text{ diminution}$$

for the $\frac{1}{8}$ th inch added to diameter of full bobbin. We have to diminish revolutions of bottom cone by $\frac{1}{31}$ st part of the total. This gives us

$$\frac{100}{31} = 3.22^{\text{revs.}} \text{ diminution.}$$

By the first pair of calculations we obtained 50 and 12.5.

By the second pair of calculations we have got 40 and 3.22.

The effect produced on the bottom cone revolutions, and consequently on its diameter, by the addition of uniform layers of roving upon the bobbin, is exactly identical with the principle of a "circulating decimal." If we had to make bobbins 100 inches in diameter, the addition of $\frac{1}{8}$ th inch upon the diameter of the full bobbin would decrease the revolutions of the bottom cone by an almost infinitesimal amount. This increase, however, would never become absolutely nil, however large the bobbins were made.

We think this illustration of the recurring decimal is so applicable that we beg to emphasise it.

Every fresh figure added to the right of such a decimal fraction is of less value than the preceding figure, take for instance, 3.33. Just in the same way every fresh layer added to the bobbin has a less value in altering the

diameter of the cones. By whatever amount we increase diameter of bottom cone, we must also decrease diameter of top cone. Here, therefore, we think lies the true *secret* of the concave and convex forms of the cone drums.

A Method of Obtaining Cone Outlines.

Having, as we think, clearly established the correct theory for the necessity of having the cones of their peculiar shape, we will proceed to lay down a method of obtaining the correct outlines of a pair of such cones.

Assume the cones to be 8 inches diameter at the large ends and 4 inches diameter at the small ends, revolutions of top cone 150 per minute and, therefore, revolutions of bottom cone 300 at the beginning of set and 75 at finish of set of bobbins, diameter of empty bobbin $1\frac{1}{2}$ " and full bobbin 4". Assume that for every $\frac{1}{4}$ inch added to the bobbin diameter the cone belt moves 3 inches, this would give 30 inch cones, providing all the length were used.

Before going any further it will be as well to impress upon the reader that, in constructing the cones for actual work it would be inadvisable to only make the calculations for the addition of every $\frac{1}{4}$ inch to the diameter of the bobbins. To be absolutely and minutely correct, it would be necessary to obtain the increase in diameter to the bobbin caused by every fresh layer placed upon it, and to use this diameter of roving in our calculations.

Our purpose is not to make such cones, but only to indicate a method of constructing them, and, therefore, we take larger figures, which show our point more clearly.

We will first find the speed of the bottom cone when the bobbin is increased from $1\frac{1}{2}$ inches to $1\frac{3}{4}$, and the cone belt has moved 3 inches, the initial speed of the bottom cone being 300.

$$\frac{300 \times 1.5}{1.75} = 257.1 \text{ new speed of bottom cone.}$$

By the application of a well-known arithmetical rule, viz., division into proportional parts, we can now obtain the new diameter of the bottom cone. The rule is—

“The sum of the revolutions of the two cones is to the revolutions of the top cone as the sum of the diameters of the two cones is to the diameter of the bottom cone. We thus get—

$$\frac{150 \times 12}{407.1} = 4.42$$

or

$$407.1 : 150 :: 12 : 4.42$$

4.42" then will be the diameter of the bottom cone at a point 3" from the thin end. We can obtain the corresponding diameter of the top cone by two methods. We can either substitute the new speed of the bottom cone for the 150 in second term of above calculation, or we can subtract the new diameter of the bottom cone from the sum of the diameters of the two cones. We will choose the latter method as being the simpler.

$$12.00$$

$$4.42$$

$$7.58 \text{ Ans.}$$

We will go one step further, and obtain in the same way the diameters of the two cones at a point 6 inches from the initial position of the belt.

The next diameter of the bobbins will be 2 inches, and, proceeding as before, we obtain—

$$\frac{300 \times 1.5}{2} = 225$$

It may be noted here that the two terms above the line are constants, and the bottom term always takes into account the increase in bobbin diameter. Clearly, increasing diameter of empty bobbin by $\frac{1}{4}$ inch reduces speed of bottom cone by $\frac{1}{6}$ th, while the addition of $\frac{1}{4}$ inch to full bobbin would only be $\frac{1}{16}$ th. It is this peculiarity that gives concave and convex form to cone drums.

Following the last calculation out, we obtain

$$375:150::12:4.80.$$

4.80 is then the second new diameter of bottom cone, and

$$12-4.80=7.2,$$

which is the second new diameter of the top cone. This method would simply need following out to the other end of the cones and to full bobbins to get the diameters of cones at all the different diameters of bobbins. We should require to make two lines 30 inches long as centre lines, one for top and one for bottom cone. In our case we should divide each of them into 10 equal parts 3 inches long, and construct perpendiculars at these points. At each perpendicular we should cut off on either side of the centre lines half the requisite diameter. These diameters having been found by the method just indicated. Draw curved lines, joining all the diameters from one end of the cones to the other. As we have before said, in constructing cones to be absolutely correct, we should obtain diameters of cones for every fresh layer put on the bobbins.

Whether the above conclusions be correct or not, they are, at any rate, given as the author's own convictions, resulting from an examination into the subject, extending over several years. After writing the MSS. of the foregoing notes upon cone drums, and when just about to commence a lecture on the subject at the Ashton-under-Lyne Town Hall, in the month of September, 1895, Mr. William Gough, a former student of the writer's, called his attention to the notes upon the same subject contained in the newly issued pamphlets by Mr. W. H. Cook. These notes are so much in accord with the author's views that they are here reproduced through the kindness of Mr. Cook :—

“TO FIND SHAPE OF CONE.”

“The amount of rove given out being constant, it is necessary to vary speed of bobbin in proportion to the increase of diameter, to prevent stretching. We will assume the cones to be 36 in. long, 7 in. diameter at one end, and $3\frac{1}{2}$ in. at the other, and the strap to move 1 in. on cone for each $\frac{1}{8}$ in. increase in diameter of bobbin. From this we shall see that if the strap moves from one end to the other the cones are long enough to make a bobbin 6 in. diameter; and, as the bobbins we are making increase in diameter from $1\frac{1}{2}$ in. to $3\frac{3}{4}$ in., or a difference of $2\frac{1}{4}$ in., or $20 - \frac{1}{8}$ in., the traverse in cones will be 20 in.

To get an exact shape of cone, calculations must be made for each layer; but it will be sufficient for our purpose to take each $\frac{1}{8}$ in. increase in diameter.

The top cone makes—

$$\frac{341.17 \times 38}{50} = 259.3 \text{ revolutions}$$

and the bottom cone makes—

$$\frac{259.3 \times 7}{3\frac{1}{2}} = 518.6 \text{ revolutions}$$

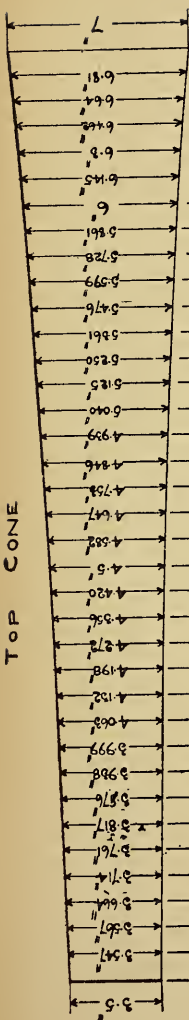
when winding on $1\frac{1}{2}$ diameter.

When the bobbin is $1\frac{5}{8}$ diameter, the strap will have moved 1 in. along the cones, and the speed of the bottom cone will be reduced in proportion to the increase of diameter, as $1\frac{5}{8}$ to $1\frac{1}{2}$, or—

$$\frac{518.6 \times 1\frac{1}{2}}{1\frac{5}{8}} = 478.7$$

and the diameter of top and bottom cones must be in the ratio of 478.7 to 259.3, and, to keep the strap at one tension, the sum of the two diameters must be constant. Therefore, as the sum of revolutions is to the revolutions of the top cone, so is the sum of diameters to the diameter of the bottom cone.

TOP CONE



DIA OF ROBBIN

BOTTOM CONE

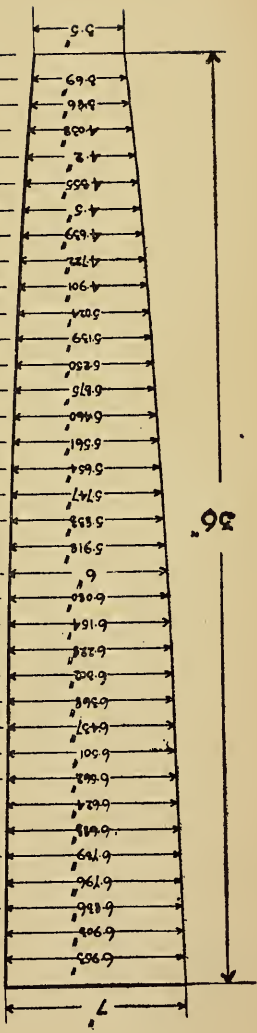


FIG. 25.

EXAMPLE—

$$738 : 259\cdot3 :: 10\cdot5 : x$$

$$\begin{array}{r} 10\cdot5 \\ \hline \end{array}$$

$$\begin{array}{r} 12965 \\ 25930 \\ \hline \end{array}$$

$$738)272265(3\cdot69 \text{ nearly}$$

$$\begin{array}{r} 2214 \\ \hline \end{array}$$

$$\begin{array}{r} 5086 \\ 4428 \\ \hline \end{array}$$

$$\begin{array}{r} 6585 \\ 6642 \\ \hline \end{array}$$

and $10\cdot5 - 3\cdot69 = 6\cdot81$.

Again. The next diameter will be $1\frac{3}{4}$ in., and the revolutions of bottom cone will be as 14 to 12, or

$$\frac{518\cdot6 \times 12}{14} = 444\cdot5$$

and the diameter of bottom cone will be as—

$$703\cdot8 : 259\cdot3 :: 10\cdot5$$

$$\begin{array}{r} 10\cdot5 \\ \hline \end{array}$$

$$\begin{array}{r} 1296\cdot5 \\ 25930 \\ \hline \end{array}$$

$$703\cdot8)272265(3\cdot86$$

$$\begin{array}{r} 21114 \\ \hline \end{array}$$

$$\begin{array}{r} 61125 \\ 56304 \\ \hline \end{array}$$

$$\begin{array}{r} 48210 \\ 42228 \\ \hline \end{array}$$

$$\begin{array}{r} 5982 \\ \hline \end{array}$$

$= 3\cdot86$ diameter bottom cone and $10\cdot5 - 3\cdot86 = 6\cdot64$ in. diameter top cone.

If these calculations are carried out to the end we shall obtain a pair of cones similar to Fig. 25.

PRACTICAL REMARKS ON THE CONE DRUMS.

By simply watching the behaviour of the roving in its passage from the rollers to the bobbins, irregularities in winding are often easily detected by an experienced, practical man. In actual working it is certain that the cone belt is often responsible for such defects. The belt has always been a weak place in this ingenious system of differential winding. As regards the piecing of the belt, for instance, different overlookers have different fads of their own. Some will insist upon having a jump piecing, *i.e.*, they will bring the two ends of the belt together without overlapping them. Others again will not hear of such a piecing, but will insist upon having one end of the belt laid over the other two or three inches or so. In other cases the two ends of the belt are buckled together. Some men do not appear to recognise at all the importance of good piecings and correct tension of the cone belts. Such procedure is a mistake. The writer would like to urge upon all concerned to pay the utmost attention to these belts. The piecings require to be made with the greatest care, and the ends of the belt paring down nicely in lap over piecings. Especial care should be taken not to let corners of the piecings and lumps belonging to the laces, etc., catch the strap fork, or such rough places to appear anyway on the surfaces of the belts as to affect their smoothness of working. A jerky movement of the cone belt will mean a jerky movement of the ends of roving. A tight belt mean tight ends, and a slack belt means slack ends, all other things being right.

Every precaution should be taken to prevent the necessity for the tenters having to tamper with the cone

belts during the building of a set of bobbins. Irregular tension of the ends is almost sure to result from such a practice. In particular are careless or inexperienced tenters apt to wind their cone belts too much up or down the bottom cone if the ends be too slack or tight.

Take a case in point. The ends are too slack, and the tenter winds the belt down the bottom cone to get them tight enough. She does too much of this, and the ends are then stretched for a time. This may be repeated several times during a set of bobbins, with the result that the ends are almost always either too slack or too tight.

Sometimes we have noticed that the belt was not started at the ends of the cones, after doffing. If other things be right the ends in this case will therefore be slack to begin with, until after a time the tenter goes and winds the belt back somewhat and probably stretches the roving. All this has been simply because the strap fork required adjusting a little.

It may be that the belt is not started at the bottom of the driven cone, and yet the ends are the correct tension to begin with. In this case there is probably a wrong wheel on somewhere, as on the end of bottom cone, for instance ; a larger wheel here having the effect of tightening the ends. It does not follow, however, that in such a case the winding is correct all through the set. If the cone drums are properly made, their diameters at all parts are calculated to be right for a certain diameter of bobbin. It would not matter if the cones were of a uniform taper, but it matters a great deal since the cones are concave and convex. If the cones be the correct configuration it would by no means do to start the belt some distance up the bottom cone and get the winding right initially by different wheels. An inch traverse of cone belt in bottom of set would reduce revolutions of bottom cone about $\frac{1}{10}$ th part of the whole, and this is necessary at this stage. On the other hand, an inch traverse of cone belt at other end

of cone would only reduce winding by about $\frac{1}{31}$ st part, which would not do at all for empty bobbins. This point the author cannot too strongly urge upon practical men. Let the thin end of bottom cone be for thin part of bobbin and *vice versa*.

It ought to be said, however, that in some cases incorrectly shaped cone drums have been applied to frames, and in such cases we have to do the best we can. If we can get convinced that our cones are wrong for our bobbins, it would probably be the best plan to get new cones, or to have the old ones altered by competent persons. There has always been too much mystery attached to the outlines of the cone drums.

A point regarding which some persons are not sufficiently careful is the mixing of empty bobbins together which differ in diameter. It is absolutely certain that two diameters of empty bobbins cannot be placed on the same frame and both be right for the winding initially. Those which are too little in diameter will have the ends slack, or, on the other hand, the larger bobbins will be stretching the roving. Equal carelessness is often betrayed in regard to the laces with which the cone belts are pieced, and the quality of the leather. Nothing is more annoying to an overlooker or tenter than having to be continually re-piecing cone belts and broken ends of roving resulting from belt-laces breaking, or even the belt itself. It is poor policy attempting to make up for bad leather by having the cone belts of extra width. A narrow, pliable cone belt is better than a wide, stiff cone belt any day. For one reason, a wide belt grips hold of diameters of the cones which differ considerably. On this account there is a comparatively great difference in surface speed of those points of the cone which are in contact with the belt at the same time, and, therefore, the driving is transferred to that portion of the belt which is tightest. No two points in the length of the cones revolve at the same surface speed.

There is only one point in the breadth of the cone belt that moves at the same speed as the surface of the cone that is driving it; the other points of the strap slipping and going faster or slower than the surface they are in contact with. The greater the width of the belt and the greater is the slippage. The power of the cone belt is, therefore, very limited, but the narrower the belt and the more perfect the grip. The writer has seen narrower belts applied with great improvement to the regularity of the winding.

DUPLEX DRIVING.

The present writer, in his practical treatise upon self-acting mules, gives illustrations and explanations of a recent and successful invention called Duplex Driving, in which there are two fast and two loose pulleys on the rim shaft, and two narrow straps instead of one broad strap.

The inventors, Messrs. Ashton and Moorhouse, of Shaw, have been fortunately able to make an application of the very same idea and principle to bobbin and fly frames. In the latter case, however, the double pulleys, instead of being placed upon the Jack shaft or main driving shaft of the frame, have been placed, so to speak, upon the cone drums shafts, which do not absolutely drive the bobbins, but which vary the speed of the bobbins to suit the winding. As before shown, some of the chief defects in connection with cone drums lie in the cone belt. Few practical men will deny that a wide cone belt is an evil, providing a narrow belt can be got to do the work. Duplex driving for cone drums enables us to have narrow belts. The cone shafts are made considerably longer, and on each shaft are placed two precisely similar ones, and instead of one broad belt there are two narrow belts, which are operated from the same source and have the same connections, and are placed on similar diameters of the cones.

It appears evident, if these belts can be kept at one tension and on the same positions of the cones, that the winding power can be almost doubled. There are two or three conditions on modern frames that enhance the value of this invention. In the first place, bobbin-leading frames are much more prevalent now than formerly, and on these frames the work of the cone drums is increased by the fact that in Holdsworth's differential motion, four out of the five wheels revolve in a direction contrary to the Jack shaft upon which they are placed.

In the second place, it is customary to make frames much longer now than formerly, and this invention seems to meet the necessary demand for greater winding power.

The increased surface speed at which thick portions of the cones revolve, as compared with the lesser diameter of the cones, is a strong argument in favour of narrow belts. This invention has certainly met with a considerable amount of success, and it remains to be seen whether any practical defects may arise in the system which will prevent its very general adoption. It is less necessary with some of the new differential motions which absorb less driving power than Holdsworth's. Fig. 25A shows the principle involved by it.

PARALLEL ADDITIONS TO CONES.

Messrs. Brooks & Doxey have patented an idea by which the thin end of each cone has a piece the width of cone belt added to it. This extra portion is not conical, but is parallel. It is fair to assume that the cone belt will bite most keenly at the thickest part of each conical surface upon which it rests at any time. This being so, when the cone belt is in its initial position on a pair of cones which are 7" and $3\frac{1}{2}$ " in diameter respectively at their extreme ends, the belt will bite on the 7" diameter of top cone

and on a diameter of bottom cone, which is somewhat more than $3\frac{1}{2}$ ". A similar effect will obviously take place all along the different positions of the belt. At the extreme thick end of the driven cone, if the final position of the belt is so far up, the 7" diameter of bottom cone will bite the cone strap, and a diameter of the top cone will bite, which is a little more than $3\frac{1}{2}$ ". This, however, will not be as much in excess of $3\frac{1}{2}$ inches as was the case at the thin end of bottom cone, because of the more abrupt taper of the latter as compared with the former. Instead of the effective taper being 7" to $3\frac{1}{2}$ ", it will be 7" to $3\frac{1}{2}\frac{9}{2}$ " on the top cone, and $3\frac{2}{3}\frac{9}{2}$ " to 7" on the bottom cone.

The parallel ends have been added to the cones in order to overcome the above peculiarities. With these patent ends, when the belt is in its initial position, it will bite on the 7" diameter of top cone, and $3\frac{1}{2}$ inch diameter of bottom cone, and these dimensions will be simply reversed at the other extreme ends of the cones.

The author is most decidedly of opinion that anything that will tend to make the winding initially correct, and to keep it so to the completion of the set of bobbins, is worth serious consideration. This would appear to be a step in the right direction. As the invention is new, it remains to be seen whether the hopes of the patentees respecting it will be realised. Fig. 25B shows the old system. Fig. 25C the new system of cones.

CHANGE WHEELS.

As most of these are connected closely to the winding, we may include a notice of them in this chapter.

There are some six or seven change wheels on a bobbin and fly frame, and it is important that we should understand the exact duties of each wheel.

PRESENT SYSTEM

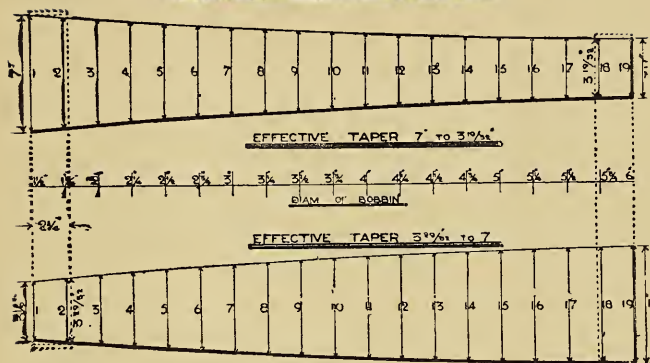


FIG. 25B.

IMPROVED SYSTEM

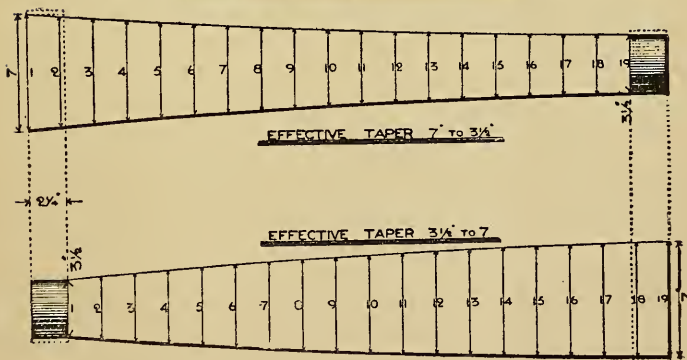


FIG. 25C.

THE TWIST WHEEL

is the most important of the series. Its chief duty is, of course, to regulate the twist. This is done by putting a smaller wheel on when more twist is required, as when going on to finer numbers. This smaller wheel drives the rollers more slowly, and allows the spindles to revolve at the same speed as previously. The same revolutions of spindle are, therefore, made to a less delivery of material. A larger wheel puts less twist in, by causing more material to issue from the rollers to a fixed number of revolutions of the spindles. With the single exception of the spindles, the twist wheel is connected more or less to every motion of the frame. Through the medium of the cone drums it is connected to the lifter and the differential motion. It is advisable to get a thorough understanding of its effect on the two latter things when it is altered. Suppose we are changing to a finer hank roving, and we put a less twist wheel on, what effect will it have on the lifter and the sun wheel? As regards the lifter, this is made to go more slowly by a less twist wheel being put on, and the writer has known many carders to imagine that no further attention need be paid to the speed of the lifter. This may be so for a small change, but not for a change in counts of any magnitude. In this case the less twist wheel slows the lifter so much as to compensate for the slower rate at which the rollers deliver the roving. But this does not meet the case. The lifter in addition requires to be traversed more slowly to compensate for the roving being thinner, with which the twist wheel has nothing to do. This is done by the lifter wheel. As

THE LIFTER WHEEL

is a driver, it follows that a less wheel should be put on for finer counts. Take now the connection of the twist wheel to the sun wheel, and consequently to the bobbins.

In changing counts a less twist wheel will cause the sun wheel to revolve more slowly. This means that the bobbins will revolve more slowly in a bobbin-leading frame, and more quickly in a flyer-leading frame. In any case, compensation is made in the winding for the reduced rate at which the roving issues from the rollers, and this does all that is required until the first layer is deposited upon the bobbin. Immediately the first layer is placed on the bobbin, it is necessary all through the set afterwards to make compensation in the winding for the thinner nature of the roving, as well as its slower rate of delivery by the rollers. As every layer put on the bobbins is thinner than when on the former hank roving, it is necessary to ease the winding to a less degree than formerly at every change. This second effect is produced by

THE RATCHET WHEEL.

A larger ratchet wheel is put on, that is to say, a wheel that is the same diameter but it contains more teeth. As a consequence the teeth are less, and each change now moves the cone strap to a less degree than formerly up the bottom cone. The winding is therefore eased to a less degree, sufficient to compensate for the finer nature of the roving. We have already shown how the lifter speed is affected by two things. The twist wheel compensates for slower rollers, and the lifter wheel compensates for thinner material during any one traverse of the lifter. The lifter speed is also affected by the ratchet wheel as follows:—

The diameter of the bobbin is increased to a less degree than formerly by the placing upon it of a layer of the finer roving. As a consequence, the lifter speed does not (so far as this one thing is concerned) require slowing to the same extent as formerly at every change of traverse. This particular effect is produced by the ratchet wheel. The lifter wheel and ratchet wheel seem to divide between

them the duties of the "strapping motion and the shaper wheel on the mule."

THE DRAFT CHANGE WHEEL,

of course, has to be changed when altering the hank roving, but it has no connection with the other wheels.

THE JACK WHEEL

is the wheel that drives the sun wheel, and should not require altering for a change in counts. Its special use is to regulate the winding to suit the empty bobbin. Suppose, for instance, when starting a new frame everything seems to be correct with the exception that the winding is too slack, a larger Jack wheel would remedy the defect.

BOTTOM CONE END WHEEL.

This wheel regulates both rate of winding and speed of lifter. When changing counts this wheel should not ordinarily need touching. Suppose, however, in starting a new frame the ends be too slack and one coil of roving was too close to another, a larger wheel at this point would tend to remedy both defects by increasing the winding power and speeding the lifter rail simultaneously. It might happen that a smaller diameter of empty bobbin was desired to be used. A larger wheel at this point would meet such a case, probably without any other alteration. It may be mentioned that closer the coils and harder the bobbins are.

CONING WHEEL,

Sometimes it is desired to alter the cone of the bobbins at top and bottom equally. The wheel that drives the hanger bar may be altered in such a case. A larger driving wheel would cause the hanger bar to move further somewhat at every change of the lifter. This would have the

effect of shortening the distance between connection of "hanger bar" to the lifter and to the top cradle of the "change motion" more rapidly.

The practical effect would be to put more cone or taper into the two ends of the bobbins.

There would thus be less tendency for the ends to run over or under, but at the same time there would be considerably less material put on the bobbin. Less this tapering is and better, providing there is no running over and under.

It is advisable to take a typical case of changing from one hank roving to another.

Suppose we are making a 4.5 hank roving, and desire to change to a 7 hank roving.

For the 4.5 hank we have on a 36 ratchet wheel, a 40 change pinion for draft, a 45 twist wheel, and a 34 driving lifter wheel. Find wheels for the 7 hank roving.

$$\frac{36 \times 2.64}{2.12} = 44.83 \text{ ratchet wheel.}$$

$$\frac{2.12 \times 45}{2.64} = 36.13 \text{ twist wheel.}$$

$$\frac{4.5 \times 40}{7} = 25.71 \text{ change pinion.}$$

NOTE.—It is probable that a portion of this last change would be effected at the back roller wheel.

$$\frac{2.12 \times 34}{2.64} = 27.30 \text{ lifter or builder wheel.}$$

NOTE.—If this change be too great for one wheel, then the small strike wheel could be altered a little as well. If we were to alter one of the driven wheels, then, of course, we should require a larger wheel for finer counts.

CHAPTER V.

BUILDING MOTION.

INTRODUCTION.

This is sometimes termed the “change motion,” the “change hole,” the “ratchet motion,” or, the “tapering motion.” It is a complex piece of mechanism; and the intricacy of its parts, combined with the vastly important results dependent upon its action, render a thorough and correct comprehension of it somewhat difficult to acquire. At the same time, such knowledge is absolutely indispensable on the part of frame overlookers, &c., who have charge of bobbin and fly frames. Probably there is nothing about a frame which demands more attention and more practical adjustment than the change motion and its connections, as the results dependent upon its action are very far reaching and manifold. It is of much more practical importance to most individuals to study this motion than to study the Jack-i'-th'-box, or differential, motion. The essential features in construction and action are alike for the different makes, but there are differences in details, some of which will be noticed later on.

SUMMARY OF CHANGE MOTION ACTION.

It is deemed best to give an epitomised description of the motion before going into details. Briefly, then, this motion is centred in two cradles or tumblers. There

is an upper cradle, which has a continuous rocking or reciprocating motion imparted to it by the lifter. There is also a lower cradle, which has an intermittent motion imparted to it by springs, or weights, which first try to pull this cradle partially round and downwards on one side and then the other. This action, however, is always prevented until a detent lever or catch is released by the movement of the top cradle. When the lower cradle is released it has a sudden movement, the effects of which are fourfold.

(a) The lifter is reversed by the strike bevels being reversed.

(b) The lifter traverse is shortened in order to give a conical bobbin.

(c) The lifter traverse is slowed to make up for the increased diameter of bobbin.

(d) The speed of the sun wheel is slowed in order to ease the winding sufficiently to accommodate it to the increased diameter of bobbin.

The building motion, therefore, at each change, shortens the lift, slows the lift, reverses the lift, and eases the winding.

The change motion will now be treated in considerable detail, with the aid of drawings. It must be distinctly understood, however, that these are lecture diagrams only, specially constructed in order to show the details and action of the parts more clearly. Some of the parts are, therefore, purposely put out of their correct working position, in accordance with this idea.

MECHANISM OF THE MOTION.

TOP CRADLE.

Referring to Fig. 26, which is a front view of the building motion, it will be seen at a glance that the central idea is the employment of two cradles **A** and **B**.

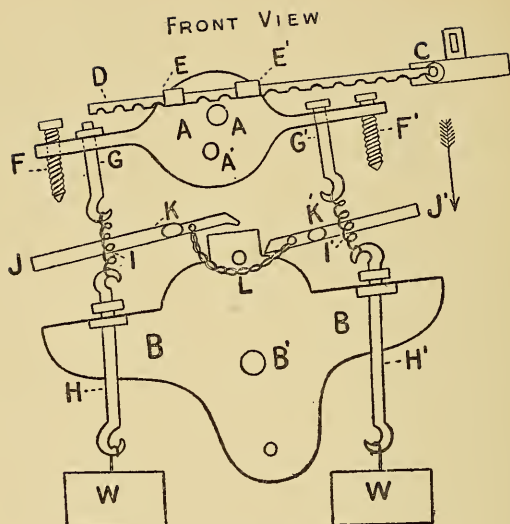


FIG. 26,

The top cradle **A** has a continuous rocking motion on the stud **A'** impelled by the lifter rail. The double slide **C** is connected to the lifter, and partakes of its movement. The round rod, or round-toothed rack, **CD** is hinged loose at **C** to the double slide, and at the other end passes through the two snugs **E** and **E'** in the top cradle. Clearly, then, if the lifter rail moves upwards and downwards alternately, the upper cradle **A** by this connection will have a rocking motion imparted thereby to it. The circle in the cradle in connection with the teeth of the rack **CD** represents the wheel that drives the rod. The snugs **E** **E'**, instead of being put above the centre **A'** of the upper cradle, are often put upon the same plane or level surface, being elevated on the diagram in order to be out of the way. Screwed fast by lock nuts to the arms of the top cradle are the adjusting screws **F** and **F'**. In actual

practice, however, these arms of the upper cradle are usually placed much more above the fulcrum upon which this cradle oscillates. Also, screwed fast to the arms of top cradle, are the hooks **G** and **G**¹. In some frames, both new and old, both cradles are centred on one stud, whereas in others each cradle is centred on a separate stud. This description refers more especially to an arrangement of the latter kind, although it will apply equally well to the former when the fact just pointed out is borne in mind.

BOTTOM CRADLE.

The lower cradle **B** differs from the upper cradle in having an intermittent and sudden movement backwards and forwards upon the stud **B**¹, instead of the continuous and comparatively smooth movement of top cradle. Passing through snugs or projections on this cradle are the double hooks **H** and **H**¹, to the bottom end of each of which is attached a weight **W** or **W**¹, as shown. Often springs are used instead of these weights. There is a raised surface or boss near the top of each of these double hooks which will allow the hook to rest on the lower cradle, but will not allow it to pass through the snug any further than this boss. They will, however, allow the hooks to be lifted up at the proper time, so that the weight is taken off the lower cradle by the action of the upper cradle. These double hooks, **H** and **H**¹, are connected to the upper cradle by the chains **II**¹ and the single hooks **G** and **G**¹. Often the upper curves of the double hooks themselves serve instead of having a special boss or swelling.

Also, belonging to the lower cradle, are the two catches or detent levers **J** and **J**¹, which are connected together as shown by a small spiral spring passing round the stud **L**, firmly pressed down upon the lower cradle, and the detent levers pivot on studs at **K** and **K**¹. Upon the top of the lower cradle are shaped two corners, one on the left hand

and one on the right hand, and the detent levers **J** and **J¹** engage alternately with these corners.

In Fig. 26 the catch **J¹** on the right hand side is shown in gear with the right-hand top corner of lower cradle, whilst the left-hand catch **J** is shown resting on the top of the cradle. One or other of these two catches always has hold of the lower cradle, except just for the instant when they are changing from one to the other.

CRADLE MOVEMENTS.

To put it briefly, during the progress of any one upward or downward movement of the lifter rail, the top cradle is moving and the bottom cradle is absolutely stationary. All this time one or other of the weights **W** and **W¹** is trying to pull the bottom cradle partially round and downwards by the double hook. It is prevented from so moving by one or other of the two catches **J** and **J¹**. When, however, the termination of the lift is reached, then this catch is released by one of the adjusting screws **F F¹**. A sudden movement of the cradle then takes place, which causes various important changes to be made, as will shortly be described. We can now deal with the movements of the cradle specifically and in detail. Let us assume that the short lever or catch **J¹** on the right hand side of the sketch has hold of the top right hand corner of the bottom cradle, and is resisting the action of the right-hand weight **W¹**, which is endeavouring to pull the right-hand side of the lower cradle partially round and downwards. The upper cradle **A** having changed or put out of action the left-hand catch **J**, now has its right hand projection moving downwards, impelled by the downward movement of the lifter. (The upward movement of the lifter would impel the left-hand side of the top cradle downwards.) This downward motion of the upper cradle will continue until the right-hand adjusting screw **F¹** comes

into contact with the outer end of the detent lever **J**, upon which it will press down until the inner end of this catch is released from the cradle and lifted clear of it. The lower cradle being no longer held fast by the detent lever, will instantly have a sudden movement of probably $1\frac{1}{2}$ inches, in an arc of a circle at its outer ends, impelled by the right-hand weight **W**¹.

The movement will be partially round and downwards on the right hand, but partially round and upwards on the left hand, inasmuch as the cradle pivots on a fixed stud or centre. The movement will continue until it is arrested by a slot in the cradle coming against a special stop; or, on the other hand, a special stop or stud in the cradle coming against a fixed part of the framework. It will, however, be sufficient to allow the left-hand catch or detent lever to drop down at its inner end and engage with the left-hand top corner of the lower cradle.

It must especially be noted that the left-hand weight **W**, during the time that the right-hand weight **W**¹ has been pulling down at the cradle, has been raised up by its connection through the double hook, chain, and single hook, to the top cradle. Clearly, if the left-hand side of the top cradle is raised, it will, by this connection, lift up the weight off the lower cradle, leaving the latter free to move at the proper time, impelled by the action of the right-hand weight. The motion of the cradles will now be reversed. The right-hand side of the top cradle will now move upwards, and the left hand downwards, and will continue until the left-hand detent lever or pigeon lever **J** is disengaged from the lower cradle and the latter rocks the other way about. Exactly the same action takes place on the left side as on the right side. This continuous movement of the upper cradle and intermittent movement of the lower cradle are always being reproduced all the time the frame is running. Moreover, it may be noticed that the two cradles always travel through the

same amount of space, in their reciprocal movement, at all diameters of the bobbin, from empty bobbins to full.

RESULTS OF LOWER CRADLE MOVEMENTS.

So far our remarks have been confined to showing how the cradles received their movement. We have now to deal with the vastly important results of these movements. Attention must first of all be directed to the lecture diagrams, Fig. 27 and Fig. 28, which give further connections of the intricate and far-reaching mechanism of the building motion, Fig. 27 having been stripped as bare as possible to avoid confusion. Upon the stud **A**¹ of the

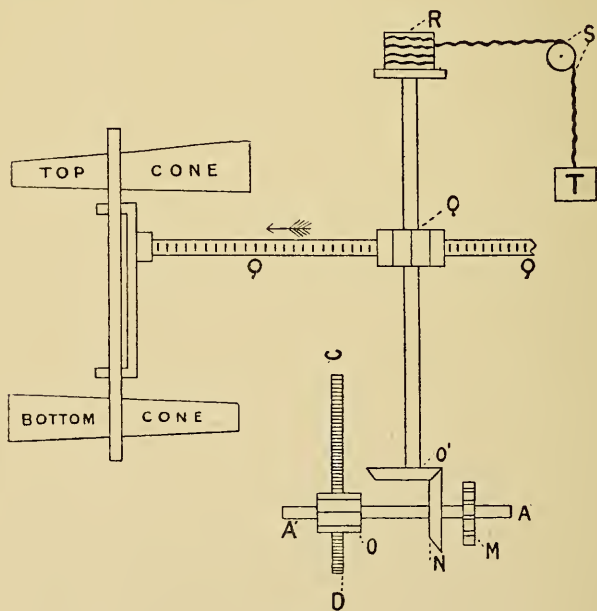


FIG. 27.

upper cradle are three wheels, **M**, **N**, **O**, as shown in Fig. 27, in which a side view of these wheels is combined with a front view of the cone drums and cone rack. The round rack, or diminishing rod **C D**, shown in Fig. 26, is given again, and for explanatory purposes is shown at right angles to the long rack, although in actual practice it is always parallel to the latter in the centre of the lift, and at an acute angle to it at other parts of the lifter traverse, **M** is the ratchet wheel, **N** is the bevel wheel for moving the cone rack through the bevel **O** on the bottom of the upright shaft. **P** is the cone rack. **Q** is the wheel for moving the rack. **R**, on the top of the upright, is a sort of pulley round which the cord **S** is wrapped, and then, passing round the guide pulley as shown, is connected to the drag weight **T**. The long rack **P** is connected to the cone belt as shown. The rack **C D**, it must be remembered, is connected to the upper cradle at **D**, and to the lifter at **C**.

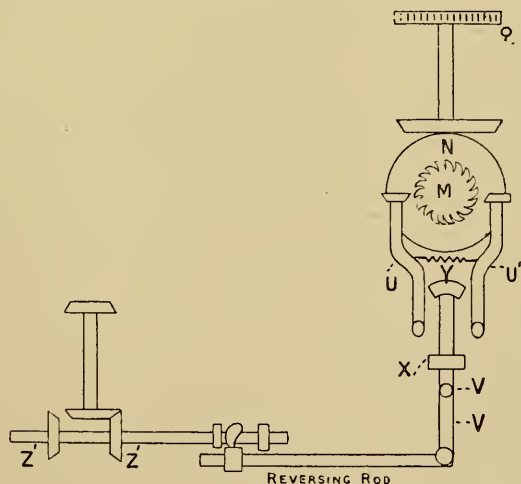


FIG. 28

In Fig. 28 is shown a back view of the ratchet wheel **M**. Here it is seen that two vertical catches or detent levers, **U**, **U**¹, are placed so as to engage with the teeth of the ratchet wheel. One or other of these two catches always has hold of the ratchet wheel, except just at the instant of changing. It may be noted here that there are four catches altogether in connection with the building motion—two horizontal catches for holding lower cradle alternately, and two vertical catches for holding ratchet wheel alternately. The two vertical catches or levers, **U**, **U**¹, are hinged at their lower extremities to the framework, and are connected together as shown by a short spiral spring. There is also shown an upright lever, **V**, having its fulcrum near the centre at **V**¹, and having a horizontal slot shaped in it at **X**. At the upper extremity of this lever there is a kind of hammer head, which, when the frame is working, strikes alternately against the catches **U** and **U**¹, just according to the movement of the lower cradle. The lower extremity of this lever is connected to the reversing rod and the reversing bevels shown at **Z**.

DISTRIBUTION OF MOVEMENTS.

Having described in detail the necessary mechanism for distributing the motion of the cradles to the proper parts of the frame, we can now examine actual transference of the movements. The great object and use of the top cradle is to release the bottom cradle at the proper time. The great object and use of the bottom cradle is to suddenly strike against one side of the slot in the upright lever **V**., Fig 28, and move this lever into a fresh position and hold it there until the termination of the next lift. The reversal of the lever sets into operation all the changes necessary at the termination of each lift. The various movements are, therefore, now centred in this short upright lever, which, at its lower extremity, keeps the proper pair

of reversing bevels in gear, and its upper extremity keeps the proper upright catch in gear with the ratchet wheel. These lecture diagrams being thoroughly understood, there will probably be little difficulty in now tracing the three vastly important results of the sudden movement of the lower cradle, and the consequently similar movement of the upright lever **X**. We have previously described how there are two weights **W** and **W**¹ each trying to pull the lower cradle round in turn. There is also a third weight, **T**, called the drag or rack weight, which is always endeavouring to turn the ratchet wheel round, and whose action we have now to consider. As shown in Fig. 27, the weight **T**, through its connection to the upright change shaft by the cord and the pulley **R**, is trying to twist this shaft round. By a little consideration the student will be able to see that when this torsional movement takes place, the shaft **A**¹, upon which the wheels **M**, **N**, **O** are placed, will also have a rotary movement of a similar character, impelled by the bevels **N**, **O**¹. Until the termination of any one lift, this rotary movement is always prevented by one or other of the catches in Fig. 28, being in gear with the ratchet wheel **M**, and resisting the action of the drag weight **T**.

We will now assume that the termination of the lift is reached and the bottom cradle suddenly rocks. There is a stud or pin connected to this cradle which strikes somewhat smartly and forcefully against one side of the slot **X** in the upright lever **V**, Fig. 28. This lever is therefore turned on the stud **V**¹, and the hammer head **Y** on the top of it is compelled to strike against that particular ratchet wheel catch **U** or **U**¹, that happens to be holding the ratchet wheel in check, thus releasing its hold upon the ratchet wheel. (In Messrs. Dobson & Barlow's arrangement the hammer head is directly secured to the stud fixed in the bottom cradle.)

Clearly, therefore, as soon as the ratchet wheel is released it will begin to move round, impelled by the drag

weight **T** at the end of the rack cord. This rotary movement, however, can only be of a very limited character, because, as previously described, the pair of ratchet wheel catches, **U**, **U**, are connected together by a small spiral spring. Moreover, when the hammer head moves one catch out of action, it leaves the other catch of the pair free to move. Previously the hammer head held the same catch out. Simultaneously, therefore, as one catch is disengaged from the ratchet wheel, the other is engaged therewith by the tension of the spring. At each change of lift the ratchet wheel is allowed to move round half-a-tooth only, and how this limited movement is regulated will be hereafter explained. The result of the sudden movement of half a tooth of the ratchet wheel is that the upright change shaft has a slight rotary movement as well as the short shaft to which the ratchet wheel is secured. This is imparted by the wheel **Q** to the long rack **P**, and to the round rack or hanger bar **C D** by the wheel **O**. Clearly, the movement in the direction of the arrow of the long rack will impart a similar movement to the cone belt, and cause it to travel slightly up the bottom or driven cone and down the top or driving cone. The reader will have learned elsewhere in this treatise that this movement of the cone belt is necessary at each change of the lift, for a two-fold object.

(1) Seeing that the bottom cone drives the sun wheel, it is quite obvious that the slower revolution of the bottom cone, caused by the belt working on a larger diameter, will have the effect of giving a slower revolution to the sun wheel of the differential motion. This is necessary in order to ease the winding sufficiently to compensate for the increased diameter of the bobbin.

(2) Seeing also that the bottom cone drives the lifter this latter will be slowed by the same change, and this also is necessary, on account of the increased diameter of the bobbins.

Reverting now to the short or round rack **C D**, which is shown vertically in Fig. 27 for explanatory purposes, instead of horizontally, as in Fig. 26, it is quite clear that the movement of shaft **A**¹ and ratchet wheel **M** will be accompanied by a slight movement of rack **C D**, impelled by wheel **O**. This movement shortens the distance between the attachment of the rod to the lifter and the fulcrum of the rod, which may be taken at half way between the snugs **E**, **E**¹ of the top cradle in Fig. 26.

The practical effect of this shortening of the rod **C D** is, that the lifter traverse is shortened in a manner which is explained later on in this chapter. Hitherto, in dealing with the results of the sudden movement of the lower cradle and the upright lever **V**, we have been examining the effects resultant from the action of the hammer head **Y** at the top of the lever **V**. We will revert now to the lower extremity of this lever. It is connected, as shown in Fig. 28, to the reversing levels **Z Z**, and it is quite clear at a glance that the movement of the lever **V** is communicated to the reversing bevels **Z, Z**¹, by the reversing rod. At every movement of the lever **V** and the reversing rod, one of the bevels **Z, Z**¹, is engaged with the small strike wheel, and the other bevel is disengaged. As these bevels drive the lifter, this change is necessarily followed by all wheels from the reversing bevels to the lifter and consequently, the lifter itself being made to revolve in the opposite direction. We have thus examined the various movements compassed by each change of the building motion. In consideration of the important results of the action of the building motion, practical suggestions and remarks of a somewhat exhaustive character will now be made in regard to working of the motion.

TO REGULATE LENGTH OF LIFT.

In Fig. 29, **A, B** are the adjusting screws ; **C, D** are the detent levers for lower cradle **E**. In order to adjust the

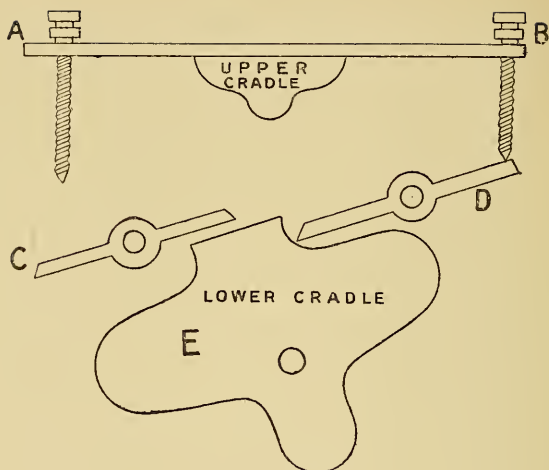


FIG. 29.

lifter traverse so as to wind the roving upon the bobbin at the correct distance from each end of the bobbin, the following method is generally adopted :—

Wind the lifter down so as to have the roving to wind on the bobbin just as far from the end as may be required, as at **F** in Fig. 30. Then set either

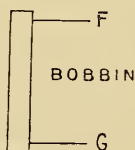


FIG. 30.

the screw **A** or **B** (as the case may be) downwards until it releases its corresponding detent lever **C** or

D from the cradle. Now wind the lifter until the roving is at the other end of the bobbin, as at **G** in Fig. , and set the remaining screw **A** or **B** to release its corresponding detent lever. Secure the adjusting screws firmly by the lock nuts shown. It may be noted that setting these screws further down shortens the lifter traverse, and vice-versa. Also when the lifter is at its topmost position, the roving is being wound on the bottom of the bobbins, and when the lifter is at its lowest position, the cotton is being wound on the highest part of the bobbin.

HOW THE LIFT IS AUTOMATICALLY SHORTENED AND CONICAL BOBBINS OBTAINED.

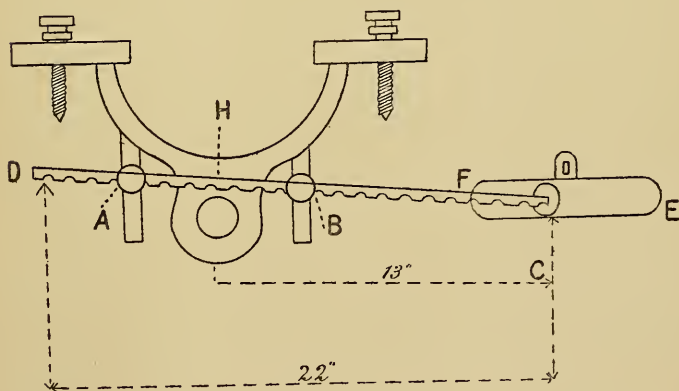


FIG. 31

In Fig. 31, **CD** is the hanger bar or diminishing rod. It passes loosely through snugs in the upper cradle, as shown at **AB**. It swivels loose in the double slide **EF**, which is secured firmly to the lifter rail, and partakes of its movement. The hanger bar may be regarded as a lever of

the first order, having its fulcrum in the centre of the upper cradle, and equi-distant from the snugs **A**, **B**, through which it passes. At the beginning of a set of bobbins, the end **C** of the bar is at the outer extremity **E** of the double slide **E F**, and at the termination of a set of bobbins it is at the inner extremity **F** of the double slide **E F**. It is moved slightly at the end of each lift by the wheel **G**, which, as shown in Fig. 27, is on the same stud as the ratchet wheel. Regarding this sketch as illustrating actual practice, it may be considered that any part of the rod **C D** which may project at any time through the snug **A** on the left of the cradle is for the time being useless, and may be left out of our calculations. The hanger-bar or tapering-rod traverses, say, something like 8 in. from right to left as the bobbins increase in diameter. As a result, the effective length of this rod, which may always be taken as extending from the centre **H** of the top cradle to the point **C**, where it is connected to the double slide, is constantly being diminished. This effective length may be taken at about 21 inches or so at commencement of set, and 13 inches or so at completion of set. We are now in a position to show clearly how the reduction of the effective or working length of the tapering-bar **C D** reduces the length of lift, and thus gives us the conical bobbin, which is so essential and useful. The adjusting or changing screws, marked **A B** in Fig. 29, and shown repeatedly in the different sketches of this chapter as being secured to the top cradle, have always to travel through the same amount of space at all parts of the set of bobbins before they cause the changes necessary at the termination of each lifter traverse. This distance may be, say, $1\frac{1}{2}$ inches or so. A moment's reflection will convince anyone that if the top cradle and adjusting screws be made to move more rapidly, the $1\frac{1}{2}$ inches traverse will occupy less time, and the changes will be effected sooner and before the lifter has travelled as far as before. A little further reflection will show anyone that such a quicker

motion of the upper cradle is secured by the outer extremity **C** of the rod **CD** being brought nearer to the cradle. To put it another way, it takes less movement of the lifter to give the same movement of the adjusting screws the nearer **C** approaches the cradle. To be quite clear on this point,

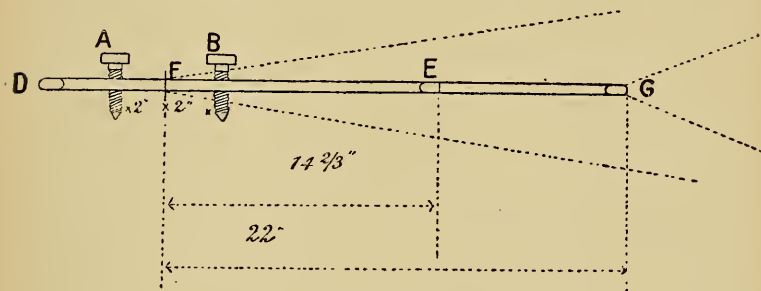


FIG. 32.

reference may be made to the simple lever of the first order shown in Fig. 32. **CD** are the two extremities. **AB** may be regarded as the two adjusting screws, each 2" from the fulcrum **F**. **E** is $14\frac{2}{3}$ " from the fulcrum, and **D** is 22". The lifter traverse may be taken at 9" for empty bobbin and 6" for full bobbin. Now we will state a simple proportion sum. It takes 9" traverse of the lifter to give $1\frac{1}{2}$ inches movement of the screws at a point 22 inches from the fulcrum, how much movement of the lifter will it take to give the same traverse to the screws at a point $14\frac{2}{3}$ inches from the fulcrum.

$$\frac{14\frac{2}{3} \times 9}{22} = 6 \text{ inches.}$$

To look at it another way. 22 inches effective length of rod are required to allow 9 inches traverse of the lifter before the adjusting screws perform the changes. How many inches effective length are necessary to allow only 6 inches traverse before changes take place.

$$9 : 6 :: 22 : ?$$

$$\therefore \frac{22 \times 6}{9} = 14\frac{2}{3} \text{ inches}$$

also $22 - 14\frac{2}{3} = 7\frac{1}{3}$ inches, which is amount of taper-rod traverse. The connection between the centre of the tapering motion and the length of lift is very clearly shown in Fig. 33, which has been kindly supplied to the author by Mr. George Shaw. The centre or fulcrum may be regarded

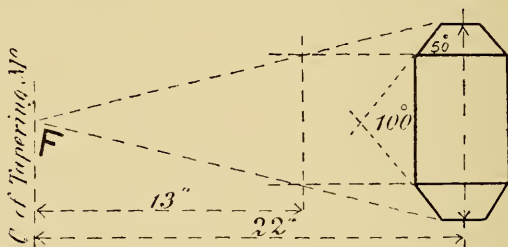


FIG. 33.

as being at **F**, and Mr. Shaw gives it as his opinion that a taper or cone in the bobbins of 50° to the horizontal is a very good practical taper. Whilst getting a fair amount of cotton on a bobbin with this taper, there is little or no tendency for the roving to run under or over at the ends.

TO SET THE TAPERING ROD.

It is vastly important that the tapering rod or hanger bar should be correctly adjusted. To do this the following method may be adopted:—Put a chalk mark in the centre of one of the empty bobbins. Wind the lifter rail about until the eye of the presser finger is exactly level with this chalk mark. Now set the rod exactly level, gauging it by placing the spirit-level on top of it, and getting the mercury

nicely in the centre of the level. As seen in several of the figures the outer extremity of the tapering rod works in a double slide, which is connected to the lifter rail. The rail and the slides are connected together by a bolt which passes through a perpendicular slot in the double slide. If the tapering rod, therefore, is not exactly horizontal in the centre of the lifter traverse, it is made so by the double slide being raised or lowered, as the case may be, this being permitted by the vertical slot. In setting the rod there is another way of testing the accuracy of the adjustment in addition to placing the spirit-level along the upper surface of the rod. This rule is:—See that the tapering rod is capable of being moved lengthways, backwards and forwards, in the double slide and snugs of the upper cradle without causing the latter to rock. If the rod is not horizontal in the centre of the lift, then the movement backwards and forwards longitudinally will cause the cradle to rock. Of course, while this test is being made, it must be disconnected from the wheel **O**, Fig. 27, that drives it. This statement needs a little examination and

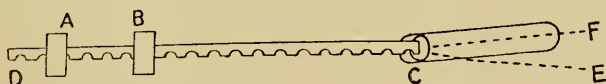


FIG. 32A,

explanation. In Fig. 32A, **A B** are the snugs in lower cradle through which one end of the tapering rod **C D** passes, whilst the other end works in the double slide as shown. We have stopped the lifter exactly in the centre of the bobbin, and yet the hanger bar is not horizontal. Move the rod towards the right hand on the double slide and the cradle will rock. This is evident from the following reasoning:—Suppose we could keep the rod at the same angle or inclination, then the end **C** would move

along the line **E**, and the cradle would not be affected. But, as a matter of fact, the end **C** of the rod is compelled to move along the straight line **F**, and this will clearly compel the cradle to rock somewhat. The practical defect that ensues, consequent upon the hanger bar not being set level in the centre of the lift, is that more taper or cone is put into one end of the bobbins than the other. How this is brought about is a matter of some complexity, and it will be noticed later on in this chapter. When the set is being commenced with empty bobbins, the outer end of the tapering rod will be at the outer extremity of the double slide. When the bobbins have attained their full diameter, the outer end of the rod will be at inner extremity of the double slide. In adjusting the tapering rod it is important that care be exercised, so as not to have it set so much to the right or left as to have it jammed against the outer extremity of the double slide at commencement of set, or the inner extremity thereof at the finish of the set. To guard against this we should wind the cone belt from one end of its traverse along the cones to the other, and at either end see that the outer end **C** of the tapering rod has a clearance from the extremity of the double slide.

COMPARATIVE LENGTH OF TAPER BAR.

It has been previously shown how the shortening of the effective length of the taper bar results in the shortening of the lifter traverse, and consequent coning of the bobbins. This principle is occasionally utilised by the initiated to effect a variation in the amount of surface of the empty bobbin which is covered by the roving. Many modern frames have provision for the double slide, being moved laterally as well as vertically, and this is a principle strongly recommended by the author. As previously detailed, this is usually regulated by change screws, made

adjustable for that very purpose. Suppose, however, we wish to lengthen the first traverse of the lifter a small portion, say $\frac{1}{16}$ th of an inch, equally at each end of the bobbin, and, for some reason or other, we do not wish to do it by the adjusting screws. We may loosen the set screw by which the small wheel that drives the taper bar is secured to the ratchet wheel stud or short shaft. Then move the taper bar a tooth or two towards the double slide, so as to have its effective length that small amount longer. Before doing this it will be perhaps as well to notice what clearance we have between the end of the rod and the outer end of the slide. If the remarks and explanations upon the length of the taper bar given a few pages previously be thoroughly comprehended, it will be easy to see that this procedure will lengthen the lift slightly an equal amount at each end of the bobbin. If the length of taper bar be varied considerably it will produce a second effect that is by no means as easy to comprehend as the one just dealt with. It will have a similar effect to that produced by putting a larger or smaller wheel on for driving the taper bar, *i.e.*, it will shorten or lengthen the cone put in the bobbins, just as the case may be. A few pages further back it was demonstrated that if 22" effective length of taper bar would give 9 inches of lift, then $14\frac{2}{3}$ inches effective length of bar would give a 6" lift. To prove the point under discussion, *viz.*, that a different length of rod will give a different degree of taper or cone to the bobbins, we will restate the problem with an effective length of rod equal at the commencement of set to just half the above length. 11 inches effective length of rod are required to allow 9 inches traverse of the lifter before the adjusting screws perform the changes. How many inches of effective length will be necessary to allow only 6 inches traverse of the lifter before the changes take place?

$$9 : 6 :: 11 : ?$$

$$\frac{11 \times 6}{9} = 7\frac{1}{3} \text{ inches}$$

$$11 - 7\frac{1}{3} = 3\frac{2}{3} \text{ inches traverse of taper bar.}$$

By a comparison of these two problems we can see that $7\frac{2}{3}$ inches of traverse tapering of rod were necessary to reduce the lift from 9" to 6" in the first case. In the second case, only $3\frac{2}{3}$ inches traverse of rod are necessary to produce the same effect on the lifter traverse, and consequently on the cone of the bobbins. It is clear, therefore, that a shorter rod would produce a more rapid cone in the bobbins, or one that was nearer to the vertical. It would produce this effect simply because every movement of the ratchet wheel and tapering rod would shorten lift to a greater degree than with a longer rod. This is exactly on the same principle that one taken from 11 is a reduction of $\frac{1}{11}$ th, whereas one taken from 22 is only a reduction of $\frac{1}{22}$ nd of the whole. Although a very slight variation in the initial length of this rod would not produce a perceptible variation in the length of cone on the bobbins, yet the author has often noticed cases where the length of rod has been sufficiently varied to produce a very visible effect on bobbin tapers. For instance, he has known tapering rods to be taken out and have an extra piece put at the end, with the sole object of putting less taper in the bobbins when it could not be conveniently effected elsewhere. At the same time the connection of the double slide to the lifter rail has had to be removed further away from the cradle in order to give the rod sufficient play in the slide. This particular property of the tapering rod will help to explain why, in many cases, we get different tapers in our bobbins, although the frames are by the same makers and all have the same wheels on. If the bars differ much in their effective length we shall have to put different wheels on in order to get the same degree of taper in the bobbins. It must be distinctly understood that the author does not suggest that there are

tapering rods at work which have only an effective length of 11 inches for the empty bobbins, as is assumed in the problem just dealt with. This extreme variation is simply assumed in order to show up the principle under discussion more clearly. As a matter of experiment the author has several times moved the hanger-bar towards the cradles about one-third of its length, working at the beginning of a set of bobbins. The result has been that the bobbins have at once shown a rapid increase in the amount of taper. It may be noted also that the jack screws have had to be put up $\frac{1}{2}$ inch or so to get the lift long enough. Also the bobbins have had to be doffed soon on account of the tapering rod soon being all used.

ON THE EQUALITY OF TOP AND BOTTOM TAPER OF BOBBINS.

It is a very common occurrence to have the taper at one end of the bobbin inclined—more or less, as the case be—to the horizontal, than the taper at the other end of the bobbin. The coning or tapering of the bobbins is affected, more or less, by so many different details as to make a thorough comprehension of it a matter of much perplexity. Whilst appearing on the surface to be a very simple matter, it is really a very complex matter. The chief, and most important, point in this connection is to have the tapering or diminishing rod exactly horizontal in the centre of the lifter traverse. If it is not so, then it is very probable that the taper, or cone, or inclination to the horizontal will be greater at one end of the bobbins than the other. Why this should be so we propose to examine in a moment or two. The hanger-bar may be originally adjusted correctly, and afterwards lose this accuracy by some such procedure as the following:—The double slide is disturbed by some means or other. In screwing it up again the workman—possibly a grinder, in the absence of the overlooker, who is elsewhere engaged—does not exercise sufficient care in

making the adjustment. For instance, the frame may be stopped in the centre of the lifter traverse, but the tapering rod may not be horizontal at that time, or, what is perhaps more probable, the bar is set something like horizontally, but the frame is not stopped in the centre of the lifter traverse. Taking a case of the former kind, and referring for illustration to Fig. 29, and assume that the bar is too high at the double slide end of it (to the left in the figure) when we are in the centre of the lift. The bar and the cradle only become level when we have lowered the lifter rod below the centre of the lift. The left-hand adjusting screw **A** has a certain distance to travel from the centre of the lift before it can release the left-hand detent lever **C** when the latter has hold of the cradle corner. Now, seeing that the lifter rail is below the centre of the lift, the bottom of the lift will be reached before the adjusting screw **A** can release the catch **C**. To make up for this the screw **A** is loosened and put further down to make the change soon enough. It must be noticed particularly that we here make compensation for loss in downward movement of left-hand side of cradle by lowering the left-hand adjusting screw. At the next upward movement of the lifter, and of this end of the upper cradle, the tapering rod and the cradle will be horizontal before the centre of the lift is reached. The movement being continued, the right-hand adjusting screw **B** will release the right-hand detent lever **D** before the extent of the upward lift is reached, and it will be necessary to raise the right-hand screw about as much as the left-hand screw was lowered, A little reflection will show that in the same frame, in order to have the conditions equal, and get the same amount of lift with the same length of taper bar, &c., there must always be approximately the same sum total distances between the bottom ends of the adjusting screws and the points at which they press down upon the detent levers, and, therefore, if one screw be lowered or lengthened, the other must be raised or

shortened. For the sake of illustration assume that when the cradle is nearly level there is one inch clearance between each of the screws and its corresponding detent or pigeon lever or catch. For both sides the total clearance is 2". If, say, on the left-hand side the one-inch clearance be reduced to $\frac{3}{4}$ inch, then the one inch clearance on the right-hand side must be increased to $1\frac{1}{4}$ inches.

BEADED BOBBINS.

One way in which the equality of the two cones upon the same bobbin is sometimes varied is as follows:—The straight bobbins, often used on short collar frames, are changed for bobbins with a bead at the bottom, in order to have stronger bobbins. The presser finger must have a certain clearance from the bead or boss on the bobbin. To obtain this clearance the lift is shortened at the bottom by the proper jack screw, and lengthened at the top by the other jack screw. We may now have the same amount of lift as before, but we are nearer the top of the bobbin with it. The hanger should now be re-set in the middle of the new lift, but the importance of this point is not recognised, and the bar is left without re-setting. The result is that the cones at one end of the bobbins are slightly shortened and at the other end slightly lengthened. *Again*.—In starting a frame it is a common and correct practice to set the hanger bar with the jack screws loose, and with the bar horizontal while the lifter is exactly in the centre of the empty bobbin. Now suppose we are having a 7" lift, we should set the jack screws to release the bottom cradle when the lifter has traversed $3\frac{1}{2}$ inches on either side of the chalk mark on the bobbin. Instead of that we go $3\frac{3}{4}$ inches on one side of the mark, and in order to maintain the lift at 7" we must only go $3\frac{1}{4}$ inches on the other side. This will vary the taper in one end of the bobbins as compared with the other end, probably giving a less amount of taper

at the end of the bobbin which travels nearest to the extremity.

SET-ON OF FLYER, &c.

Odd bobbins are often affected as follows:—Spindles are generally marked just above the shoulder to determine the amount of set-on of the flyer, *i.e.*, how much the top of the flyer shall go down the spindle top, or thin part. Dirt may get in the flyers at any time, which will not allow the flyer to have enough set-on. On the other hand the parts may become worn and let the flyer have too much set-on. Either of these defects will cause a bobbin to have a different cone at one end than the other, by allowing the lift to be made too much towards one end of the bobbin. *Again.*—It is usual to take the nearest spindle to the frame end when setting anchor bar. This spindle may be wrong, and will give a false setting of the taper bar.

NON-HORIZONTAL TAPERING ROD.

We have now to examine the reason why this disturbance of the horizontal position of the tapering rod in the centre of the lift should cause the bobbins to have more taper in one end than the other. Quite a number of little points seem to enter into the problem. These result chiefly from the fact that the building motion is largely composed of a number of levers. We should not be far wrong if we defined it as being “A combination of levers for performing the changes.” The upper cradle may be regarded as a lever of the first order, having two arms on each side of the fulcrum, all having to be considered. The lower cradle may be considered as a lever of the first order, both of its arms affecting the problem. There are two detent or “pigeon” levers or catches which hold the lower cradle in position alternately. The two catches for alternately holding the ratchet wheel may be regarded as levers of the third order.

It is a lever of the first order which is acted upon by the sudden movement of the lower cradle, and which, therefore, sets the changes in motion at the termination of each lift. The tapering rod or hanger bar itself may be regarded as acting in the double capacity of a lever of the first order, and a lever of the second order. Almost the whole of the other parts of the building motion consist of framework, &c., necessary for the effective operation of these levers.

It has just been seen how inaccurate setting of the tapering rod will be followed by one of the adjusting screws in the top cradle being shortened and the other lengthened. The lecture diagrams in Figs. 34 and 35 are intended to show how this variation in the screws may affect the changes. Fig. 34 illustrates a type of top cradle as made several years ago, and of which there are large numbers at work in different places. In this arrangement the top and bottom cradles are both on the same central stud or fulcrum, and this necessitates the arms for the two adjusting screws to be placed four or five inches above the fulcrum, as shown in Fig. 34. Assume, in order to show our point, as in this Fig. 34, that the left-hand screw has been considerably lengthened and the right-hand screw considerably shortened, much more, indeed, than would be likely to occur in actual practice under any conditions. **E** is the lower or acting point of the left-hand screw. **D** is the acting point of the right-hand screw. **A** is the fulcrum. **B** is the left-hand detent lever, and **C** is the right-hand detent lever. Now, it is seen that two circles have been described from the fulcrum **A**, taking as a radius the acting points of the adjusting screws. The important point now to be noticed is that the circle described by the long or low screw strikes the detent lever at near the fulcrum at **F**, whereas the high or short screw on the right hand presses on the detent lever at **G**, which is much further from the fulcrum of that lever. The author

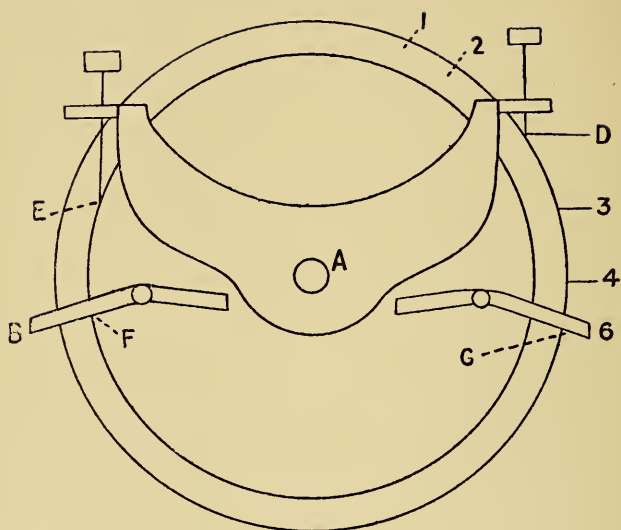


FIG. 34.

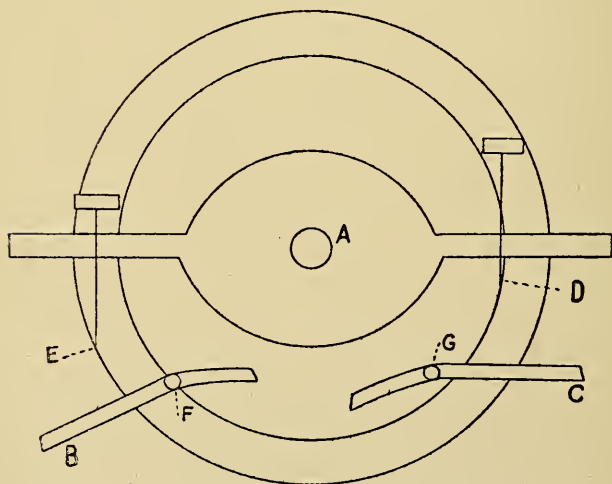


FIG. 35.

has often watched the action of the parts in such a case, and it seems clear that in the former case the detent lever is released from the lower cradle in a readier and quicker manner than in the latter case. It seems to strike the lever at a different angle, and there is less loss by sliding along the lever whilst the change is being effected. This effect is not altogether counterbalanced by the fact that the shorter screw will move at a greater surface speed, in consequence of being operated simultaneously with it, from the same centre. This is added to the fact that the detent levers have an inclined surface. The lecture diagram Fig. 35 is more in accordance with a style of building motion frequently made at the present time. The two cradles have separate central pivots. The fulcrum for the top cradle is placed higher than the fulcrum for the bottom cradle. The adjusting screws, therefore, have to be arranged with their acting or lower extremities much lower than before in relation to the fulcrum from which they are operated. The letters in Fig. 35 are exactly the same as in Fig. 34. It will be seen, however, that whereas in the former case a very low screw gave a very small circle and a very high screw gave a large circle, the effect in the more modern case is exactly the opposite. Whatever variations result in the changes from short and long screws in the former example will be probably reversed in the latter case. Another idea worthy of consideration in connection with the screws being set with their acting points at different distances from the fulcrum, is that there may be a greater amount of downward movement or releasing power in one case than the other with the same circumferential traverse. Again, by having a short and a long screw, one side of the cradle has to traverse lower down in relation to the central pivot than the other side. Take the construction of top cradle shown in Fig. 35, and note that in actual practice the detent levers **B** and **C** would be placed higher in relation to the centre than as

given in the sketch. The left arm of the cradle has to move higher up than the right arm, during their reciprocal traverse, in order to compensate for the longer screw. By this means the actual point of the left hand screw will have the same circular movement, but a less downward movement. Inasmuch as the downward movement represents the releasing power, it is clear that we have a key to some of the variations found in the tapers of the bobbins, whether one end of the same bobbin is compared with the other end, or the bobbins from one frame are compared with those from another frame. In the case of the same frame, the amount of downward movement lost by one side of the cradle will be gained by the other, and this will give a double ratio for varying degree of coning. Just to illustrate this point more clearly, we may exaggerate the case, and assume that in Fig. 34 the right arm of the cradle rocks from 1 to 2 on one frame. On another frame it rocks from 3 to 4. It is very obvious that in the second case we obtain with the same circumferential traverse as in the first case a much greater amount of downward or releasing movement. In other words, the movement of the lifter one way would impart a quicker downward or releasing movement to the cradle than the traverse of the lifter in the opposite direction. In the style illustrated in Fig. 35, this bad effect cannot as readily take place, inasmuch as the arms of the cradle to which the screws are attached are a great deal more in a horizontal line with the fulcrum of the cradle than in the former case, when the hanger-bar is horizontal. In the former case the acting ends of the screw are always above the fulcrum, and they never are in a horizontal line with it, and we, therefore, contend it is never possible to obtain the maximum amount of vertical movement that can be secured by revolving the end of a lever on its fulcrum for a given limited distance. It is different in the other style, where the screw arms of the top cradle move through an arc of a circle which extends a little above and

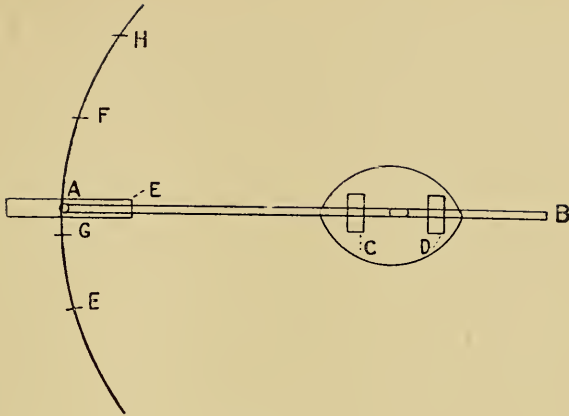


FIG. 36.

a little below the central pivot of the cradle. So far we have not examined the effect produced by the action of the double slide itself upon the variable coning of the bobbins. Referring to the lecture diagram Fig. 36, **AB** is the tapering rod, **CD** are the snugs in the upper cradle through which it passes, **E** is the double slide attached to the lifter rail, **E, G, F, H** is the arc of the circle through which the end **A** of the tapering rod would be compelled to pass if the lifter had a sufficient amount of traverse. Let **E** to **F** equal the amount of the lifter traverse when the taper bar is set horizontal in the centre of lift. Let **G** to **H** be an equal amount to **E** **F**, but to represent the traverse of the end **A** of the rod when the double slide is set too high. Clearly there is more vertical movement imparted to the end **A** of the tapering rod in the former case than in the latter case with the same amount of lifter traverse. This variation is reproduced in the upper cradle, and affects the coning of the bobbins. Whatever loss there may be in vertical movement of the end **A** of the taper-rod is always taken up by horizontal movement in the double slide. The

end **A** of the hanger bar always has a compound movement made up of horizontal and vertical motion, and approximating to a circular motion. The vertical motion is greatest and the horizontal motion is least when the rod is itself horizontal, and the point is simply referred to because the double slide itself, which operates it, is compelled to move in an absolutely vertical line. Irrespective of the points that have just been discussed, the coning of the bobbins may be affected by something getting worn, as, for instance, the top corners of the lower cradle, where the detent levers engage, or even the levers themselves.

SPRINGS VERSUS WEIGHTS.

In Fig. 26, upon which our elementary description of the "Building motion," or "Box of tricks," was based, two weights, **W W'**, are described as giving motion to the lower cradle at the proper time. On a great many frames, at any rate old ones, instead of these two weights there is a single spiral spring which does duty for both sides of the cradle. This is shown in Fig. 37, along with its connections. **A** is the spring referred to. It has a screwed part at the bottom which passes through the framework **B**, and is secured by lock nuts as shown. By this means the spring can be made to exercise a greater or less amount of tension. It is hooked round a stud at the top, in the beam **C**, as shown. This beam has a rather peculiar action, which requires some little consideration. It is not fixed to the framework at all, but is sustained, as it were, by the two hooks **D E**. The hooking of the spring to it also helps to keep it in place. It can either act as a lever of the first order, working on the central stud, or, if a sufficient amount of force could be applied equally to the two double hooks **D E**, it would be lifted bodily, this upward action being resisted by the spring **A**. The hooks **D E** are connected at the top to the upper cradle. Suppose, in actual practice, the left arm of

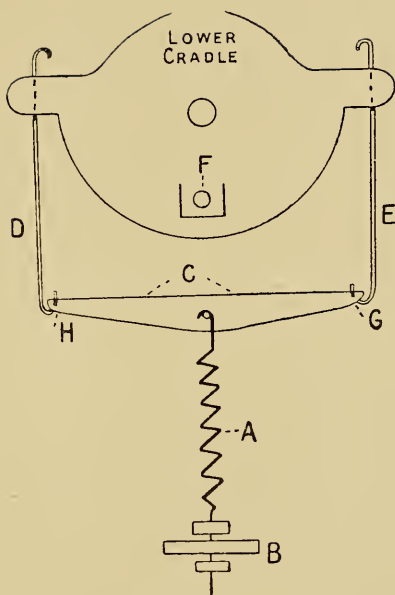


FIG. 37.

the top cradle be raised. The hook **D** will pull at the left end of the beam or lever **C**, and cause it to turn slightly upon the central pin. The right end **G** of the lever **C** will tend to go downwards. This downward movement of **G**, however, can only take place to a very limited degree, as it will be arrested by the hook **E**, which cannot move far on account of the hook at its upper extremity coming against the arm of the bottom cradle. The result is that, as the upward movement of hook **D** and lever end **H** continues, the spring **A** is put under considerable tension, inasmuch as the fulcrum of the lever **C** is for the time being transferred to the other end **G**, and the centre of the lever

has an upward movement. Regarding the spring **A** as the weight, the lever **C** is for the time being transformed into a lever of the second order. A little reflection will show that when the spring is put under tension a considerable bearing-down force devolves thereby upon the hooks **D E**. The pressure on the left hook **D** is for the time being wholly sustained by the upper cradle and hanger-bar. The pressure on the right hook **E** devolves upon the lower cradle. When, as previously detailed, the right-hand detent lever is raised, and the lower cradle thus released, then the tension of the spring compels the cradle to suddenly rock. By this peculiar and exceedingly ingenious arrangement it is clear that the motion of the upper cradle not only takes the weight off one side of the lower cradle, but at the same time it puts extra weight or turning force on the other side just when it is wanted. Presuming the right hook **E** to be raised, the exact reverse of the above action is produced. In some cases two springs and a lever are used instead of the weights, and this, in some respects, is the best method of all, as each spring is alternately made to exercise a torsional effect, first on one side and then the other side of the lower cradle, in a very convenient manner.

LOWER CRADLE CHECK ARRANGEMENT.

The attention of beginners is particularly directed to the stud **F** in Fig. 37, in the centre of the lower cradle. When the latter makes its sudden movement at the termination of each lift, the stud **F**, which is connected to the cradle, comes into contact with one side of the slot or fork in which it is placed, and which is secured to the framework. When the cradle changes the other way, then the stud strikes against the other side of the slot or fork. By this means the extent of traverse of the lower cradle is checked or regulated. The traverse should be just sufficient to allow the proper detent lever to fall into the top corner of the

the lower cradle. The cradle is then kept stationary until the termination of the next lift by the detent lever holding against it one way, and the stop or stud **F** holding against it the other way. A similar check arrangement for lower cradle is provided on all makes of frames.

REGULATION OF CHAINS, HOOKS, ETC.

It is exceedingly important that the chains, hooks, etc., in connection with the cradles, should be kept at the correct length, so that when renewals are made the changes shall be performed properly.

CHAIN TOO SLACK.

If a chain be too slack the result is that the hook and weight, or spring attached to it, are not lifted up enough. The double hook has a bead or head attached to it, which rests upon the lower cradle, and thus throwing the weight on the cradle causes the changes to be made at the proper time.

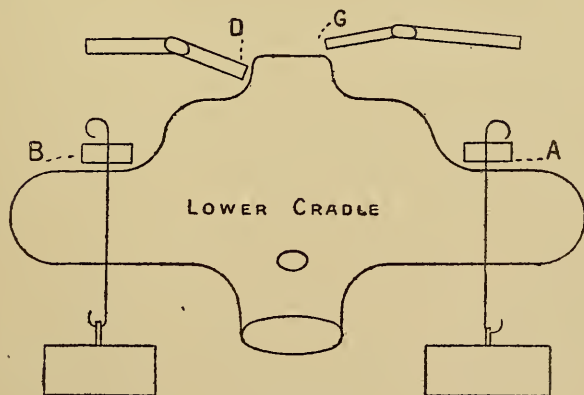


FIG. 38.

Fig. 38 shows the lower cradle and the two double hooks. At **B** the projection on the double hook is seen resting on the cradle. Often the hook itself serves without any other projection. At the time **B** is resting on the cradle, **A** on the other side should be raised by the connection to the top cradle and lifter. Now, suppose the chain which pulls **A** up be too long, then **A** will not be lifted up enough; and when the termination of the lift is reached, and the right side of the cradle suddenly moves upward, its motion is arrested too soon by the cradle coming against **A**. The cradle cannot, therefore, change far enough, and the right-hand catch cannot engage with it, but will stop with its corner as at **C**, Fig. 38. As a result the lifter will probably stop altogether, as neither one nor other of the reversing bevels will be properly in gear. The roving will wind all in a lump at one end of the bobbin. *Rule*: When one end of the cradle is up, and the change has just been made, there ought to be not less than $\frac{1}{8}$ in. clearance between cradle and hook top.

TIGHT CHAIN.

If a chain be too tight, it will cause one of the detent levers to be wedged, as it were, more tightly against the top corner of the cradle, as at **D**, Fig. 39. This will load the lifter, or cause it to have more work to do in releasing the detent lever. As a matter of fact, there is always the maximum strain on the anchor bar and the springs, &c., just when the detent levers are being released, and the minimum strain just when the release has been effected. If a strong spring be used, as in Fig. 33, it will put an undue tension on the spring, which will first devolve on the top cradle or spectacle bracket, and then on the anchor bar, as upon the latter the cradle is dependent for its motion. This means loading the lifter and the cone belt.

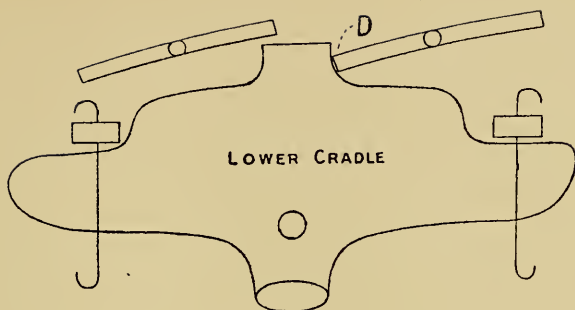


FIG. 39.

LOADING THE LIFTER AND SLIPPAGE OF CONE BELT.

This is one of the most important practical points that can be dealt with about a bobbin and fly frame. As, moreover, it is a point which is generally overlooked, even by very practical men in charge of frames, let alone students, it is important that we should now investigate it.

We have just stated that a very powerful tension put upon the chief building-motion spring or springs would load the anchor bar and the lifter and the cone-drums. In order to realise this point fully, it must be remembered that in all frames the cone belt drives the lifter rail and bobbins in their upward and downward movement. The lifter rail is balanced with weights and chains on the same principle as a hoist, although the correctness of the balance cannot be the same in all parts of the set, on account of the bobbins being at one time empty and at another time full of roving. Clearly, then, if the lifter be unduly loaded by any circumstance, this extra load devolves upon the cone belt. If this belt be at a good tension, then it may overcome the load, if the latter also be only added to a reasonable amount. If the belt be slack, or the extra load be great, the belt will be caused to slip, and, therefore, the ends will go slack. The

writer has no doubt whatever that this fact will help to explain a seeming mystery in the winding in many a case. There are several things about the building motion which will load the lifter unduly, and thereby the cone belt. If the detent levers for the lower cradle are too strongly held against the corners of the latter, they will take too much releasing, and thus load the lifter just before the termination of the lift. The practical defect is that the cone belt is caused to slip and the ends to become slack at that point. The author, in common with other practical men, has often noticed this slackening of the ends just before the termination of the lift. Now, in addition to the above evil, the ordinary swing or train of wheels for driving the bobbins consists of an epicyclic train of wheels, and this produces an action which, at one end of the lift, tends to increase the revolution of the bobbins, and at the other end of the lift tends to decrease the revolutions of the bobbins. Whether the frame has the flyer to lead or the bobbin to lead, the result is that there is a tendency for the ends of roving to slacken at one end of the lift and to tighten at the other end of the lift. This point will be more fully dealt with later on in this treatise, but it is necessary for us to notice particularly at this point that if by this means a tendency to slacken the ends exists, and at the same time there is a tendency to slacken the ends by loading the lifter, then these two, added together, may produce a very perceptible loss in winding. Neither of these factors is sufficiently appreciated by many practical men, and the author is convinced that herein lies the secret of a seeming mystery in the winding in many a case.

There are various ways of loading the lifter, and thereby the cone belt. For instance, the collars for the bobbins and bobbin wheels, whether they be long or short, may be, and as a matter of fact often are, some of them too tight, or a little out of centre with the spindle. This, of course, causes them to bind against the spindles in their upward or

downward traverse, and, naturally, the lifter and the cone belt are thereby loaded.

Again: It not unfrequently happens that the long lifter shaft containing the small pinions for impelling the lifter up and down may be binding in some of its bearings. Clearly this will make it heavier to revolve, and as this shaft is invariably driven from the cone drums, the natural consequence is more work for the cone belt, and possibly a slight loss in winding and consequent slackening of the ends. Probably the best way of testing whether this evil exists or no is to prop the lifter up by pieces of wood resting on the bottom rail, and putting all the lifter shaft pinions out of gear, and then endeavouring to turn the lifter shaft by hand. It should then be capable of easy revolution with very little manual effort. Extra work may be put on the cone belt in other ways. If the brackets or arms that connect the lifter rail to the vertical lifter racks are anyways untrue, there will be a tendency to twist the lifter rail, bind the collars against the spindles, and load the lifter and the cone belt.

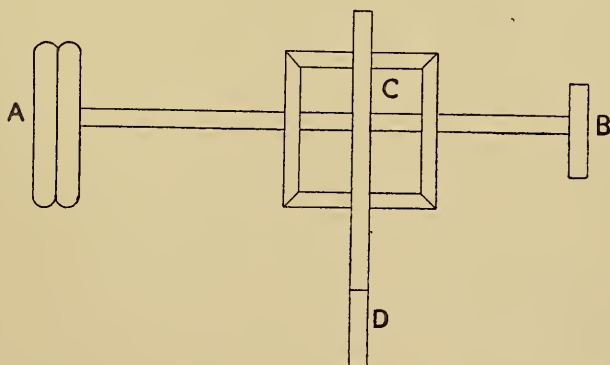


FIG 40.

In Fig. 40, at **A**, are the fast and loose pulleys, at **B** is the twist wheel, at **C** is the sun wheel, and **D** is the wheel that drives the sun wheel, and is itself operated from the cone belt. When frames have been working for a good length of time, and particularly if the oiling has been neglected, the bearing for the shaft at the twist wheel end becomes worn at the bottom side, because of the bearing-down action caused by the carrier wheel, which is driven by the twist wheel. At the same time, the bearing at the other end of the shaft may become worn by the upward pressure induced by the combined action of the driving belt, which pulls upwards at the pulleys, and the action of the spindle driving train of wheels acting below the shaft. The result is a slackness in the bearings, which the Author has often noticed to be followed by a false gearing together of the sun wheel **C**, and the small jack wheel **D**. A bearing-down action has taken place on the sun wheel, which has caused these two wheels to be too heavily geared, and has thus placed extra work on the cone belt. This, of course, has had a tendency to produce slack winding. It is probable, also, that when the "swing" train of wheels are very deeply geared, there is a little extra work thrown on the cone belt, as the latter controls the reciprocal traverse of these wheels, although it does not give them their revolution. A point which is probably more self-evident than the above is that, if any of the wheels that are driven by the cone belt are too deeply geared, or otherwise made heavy to revolve, then extra work is imposed on the belt, which may cause it to slip, and result in slack winding. The wheels alluded to include the train of wheels that drive the sun wheel on the one hand, and the reversing bevels on the other hand; also the wheels that connect the reversing bevels with the lifter shaft, and by which the latter is driven. In several cases the author has known the hanger-bar to bind against the sides of the double slide to a sufficient degree to cause

running off at the ends of the bobbins. There are innumerable little mishaps that may occur to the building motion, and an idea of which ought to be conveyed to the student.

RATCHET-WHEEL CATCH SLIPPING.

The following may be regarded as typical of the kind of thing alluded to :—

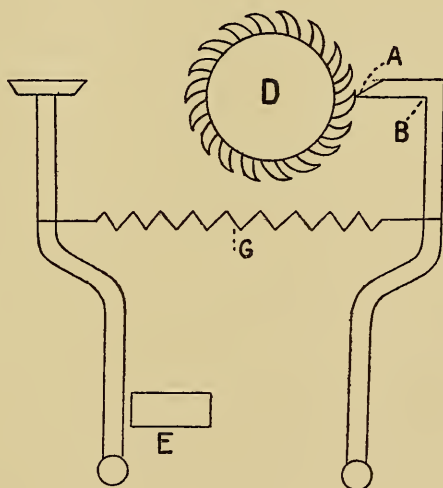


FIG. 41.

In Fig. 41 are shown the ratchet wheel **D**, the block **E** for reversing the catches, the spring **C**, and the catches themselves, with the left-hand catch out of gear, with the ratchet wheel and the right-hand catch in gear. Suppose the right-hand catch becomes worn at **A**, then it is liable to allow the ratchet wheel to slip a tooth or two at the change, and produce slack winding, by allowing the cone belt to move too far up the bottom cone. It happens occasionally

in such a case that the overlooker, instead of devoting a sufficient amount of time to discovering the proper cause, will put on a larger ratchet wheel to rectify the winding. This it cannot possibly do. It will get the cone belt on a false diameter of the cones, and render absolutely correct winding impossible. The ratchet wheel has slipped because the catch is worn too blunt and short at the point **A**, and, consequently, has an insufficient bite on the teeth of the wheel. The proper remedy would be to file or grind the point at **A** sharp enough again, and at the same time to take some off the catch at **B**. If this latter is not done it may leave the engaging point **A** of the catch too short, and allow it to continue slipping. A similar effect may be produced by the teeth of the ratchet wheel becoming clogged with small portions of dirt.

RATCHET-WHEEL SPRING OFF.

To take another case in point. The Author was fetched to a frame in which all the ends were wound slack on the spindle points, somewhat after the manner of slackening the ends when ready for doffing. Upon going to the building motion it was found that the spring **C**, shown in the last figure, had dropped off, or been knocked off unwittingly by carelessness on the tenter's part. By simply hooking the spring on again, all the parts of the frame were in trim again for working so soon as the ends were made right. It is this small spiral spring that always holds the catch in gear with the ratchet wheel, and when it fell off the ratchet wheel was free to revolve, This it immediately did, impelled by the drag weight, and thereby allowing the cone belt to traverse to the thick end of the bottom cone. Consequently the winding was made too slack. At the same time the anchor bar was moved to its shortest working point. On some makes of frames this spring is neatly arranged so that it cannot very well fall off.

ANCHOR BAR DISARRANGED.

Again, it often happens that some derangement may occur in the anchor bar. For instance, the small coning wheel that drives the bar may become loose, or by some accident, such as a bobbin dropping on the bar, it may get broken. To set the bar again, or to put a new bar in, will not be a matter of much difficulty, providing the frame is commencing a new set of bobbins. Suppose, however, the bobbins are, say, half full. Such a derangement may be compared to the copping bowl, or some other connection of the locking lever of a mule, coming loose before the thickness of the cop has been attained. If the greatest possible care be not exercised, the bobbins will have the rovings run over or under at the ends. If the bar be put in with a little less effective length at work, then the lift will be shortened at both ends. If the bar be put in with a little more effective length, then the lift will be lengthened at both ends. In such a case the safest plan will generally be to doff the bobbins at once, and have them divided out amongst the spinners, so that no one spinner shall have an undue proportion of pieces of bobbins to work up. If the bobbins are not doffed, then it will be as well to err on the side of having a shorter effective length of bar at work rather than a longer effective length than formerly.

BUILDING-MOTION MAINSPRING.

This spring, shown at **A** in Fig. 37. may be too weak, or, one of the two springs used in some new motions may be too weak, so that when the detent levers are released the changes are performed too feebly, and the lower cradle is left disengaged from both horizontal detent levers. If the changes at the termination of both the upward and the downward lift are performed very poorly, it often is an indication that the mainspring requires tightening. If the

lower cradle is not engaged with either of its catches, and the reversing bevels are disengaged, then the lifter stops, and the roving is wound all at one end of the bobbins.

CHANGING BUILDING MOTION BY HAND.

Owing to some disarrangement in the parts of the motion, or when testing the working of some of the parts, it is often necessary to perform the changes by hand.

(1). Release the detent lever that has hold of the lower cradle. (2). Change the cradle to the other position by hand. (3). See that all the results follow, viz., that the hanger bar and the long rack move, also that the reversing bevels change.

This changing by hand often leads to the detection of some ailment or obstruction about the motion.

RUNNING OVER AND UNDER OF BOBBINS.

This evil is one of the worst and most troublesome for spinners that can exist in bobbins. At the same time, it is one of the most common evils—at any rate on some makes of frames—particularly old ones. There are a great many causes for these slattered bobbins, some of which will now be briefly pointed out.

LIFTER DRIVING CHANGE WHEEL.

This is often fastened with a key or pin and a nut, after the style of the draft change pinion, only a stronger key. Occasionally the nut will work loose, and the wheel, by continually having its motion reversed, has a tendency to wear the key round, and then it means a slight back lash

and a dwell of the lifter at every reversal. This, of course, tends to run the bobbin over at the ends. This wheel on some frames is too inaccessible. On others it is quite easy to change.

SMALL STRIKE WHEEL.

This wheel, of all the series that drive the lifter, is probably the most likely to get wrong one way or another, and cause running over or under of the bobbins. It is usually fastened with a pin and a nut. The nut often works loose, and, the wheel being slack, will soon cause the pin to break. There is usually plenty of work for such a little wheel to do, and it does not last any longer from the fact that the weight is taken first off one side and then the other of this wheel, just according as to which particular one of the pair of reversing bevels is in gear with it. Clearly, also, the fact that the pair of wheels that it drives are alternately being put in and out of gear with it, cannot but conduce to the destruction of the teeth. It really is on many frames a terrible little wheel for getting wrong, and is generally one of the first things a carder will look at in cases of running under and over of all the bobbins. To renew this wheel on some frames that have the plate wheel and the jack wheel on the same shaft, it is necessary to take the whole shaft and wheels out.

LIFTER-SHAFT END WHEEL.

This wheel will occasionally get loose and cause slattering of the bobbins, but not often.

LIFTER-SHAFT SMALL PINIONS AND LIFTER RACKS.

Occasionally, but very seldom, the small lifter-shaft pinions will break. If they do break, it is generally a very troublesome affair to replace them. The Author has, at times, seen broken pinions working and making ugly places in the bobbins. They have been left working for

want of time, and new wheels possibly. Now, in almost all such cases, it is very probable that the better plan, if renewals cannot be at once made, will be to put them out of gear at once and work without them. There is usually one lifter-balance weight to every pinion, and this ought to be left on to keep the lifter at that point something like to its place. This can be done probably without any perceptible detriment to the bobbins, at any rate after the first set. If the broken wheel be left on, then, as the Author has actually witnessed, the bobbins will be all right until the broken teeth come into gear with the rack wheel. Then there is an erratic movement of the lifter at that point which results in a defective bobbin at one part of the lift or another. As we have just stated, it is not often these small wheels do break, speaking comparatively. Generally the racks with which they engage will break instead, if anything gets wrong in the working. These vertical racks are comparatively easy to replace, and a stock should always be kept on hand proportionate to any possible requirements. The fact that the rack will break before the pinion indicates an excellent principle in mechanics which is utilised at various points in cotton-mill machinery. It is a case of taking the lesser of two evils when both of them cannot be avoided. The principle referred to is this:—At some places there always exists a liability to breakages of parts of machinery. In such cases it is a good plan to make that part the weakest which can be most easily replaced. Considerable care must be exercised in putting these new racks in, as if they are badly fitted there is sure to be something very wrong at one portion of the lift or another.

BOTTOM CONE END WHEELS.

On many frames there are three wheels at this point, which experience has taught the author are somewhat

liable to wear. The centre wheel of the three is a carrier wheel ; and, being geared at both sides, appears to be much more liable to wear than the other two. These the author has known to be so badly worn, or to have some teeth actually broken out, as to affect the winding. There has been a slight slackening of the ends, which has been traceable to this cause. Particularly has this been the case just after doffing, when these wheels run always at a much quicker rate than afterwards. The slackening of the ends has been most noticeable when starting the frame.

LIFTER-WEIGHTS TOUCHING FLOOR.

If the chains for these weights become too slack, and allow the weights to touch the floor, the rovings will have a tendency to run under. This would be the same if some obstruction was in the way of the weights.

Note.—It must always be remembered that when the lifter is at its highest point the winding on is taking place at the lowest point of the bobbin. The bobbin has then reached its maximum height, and the presser finger, from which the roving issues to the bobbin, is then at the bottom of the bobbin. When the lifter is at its lowest point, the winding on is taking place at the highest part of the bobbin.

On some old frames, as, for instance, Messrs. Else's, there is an old make of swing called the " telescope swing." This is shown in Fig. 42. **A** is driven from the differential motion. **B C** is a cross shaft, supported in proper bearings, and extending from the jack shaft to the bobbin shaft as shown. **D** is a compound wheel on the first bobbin shaft **F**. **E** on the second bobbin shaft **G** is driven by **D**. The cross shaft **B C** has a swinging or oscillatory motion, as in an ordinary " swing," with straight tooth wheels.

The writer has witnessed considerable trouble with these, particularly on bobbin-leading frames, and when

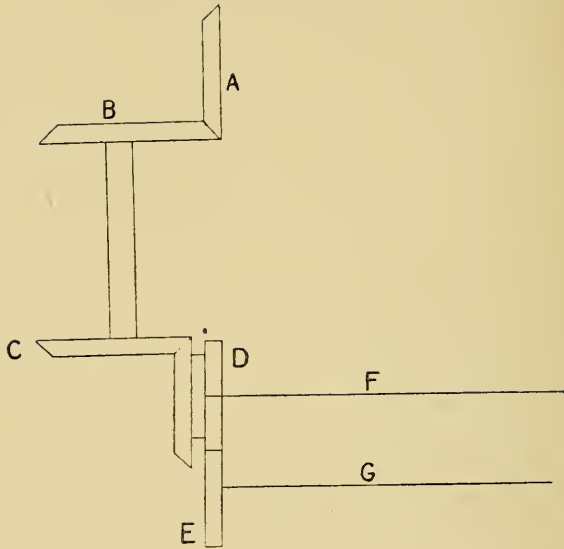


FIG. 42.

they have been run at a good speed. Indeed, the wear and tear has rendered the expense and trouble of renewals very great, until lessened by the introduction of wheels of coarser pitch and stronger teeth. With this style of swing there appears to be a very great difficulty in getting bobbins free from running over and under. The friction set up by the various parts, and the weight of the parts, &c., seem to re-act on the cone-belt and the lifter speed, and the building motion, so that there is a loss at the change of the lift, which has a strong tendency to cause slattering. It does not appear that any "swings" of this style are being made at present, and, certainly, the author's own experience of it is entirely condemnatory.

RACK WEIGHT.

Occasionally some obstacle may ease this weight, in which event the cone belt and the taper bar do not move promptly, and the winding is not eased with sufficient swiftness.

The causes for running over and under hitherto alluded to are chiefly such as would be likely to affect all, or almost all, the bobbins on a frame. There are, however, many purely local defects which would be detrimental only to individual bobbins. The following are instances:—

(1). If the snugs or bits on top of the small bobbin wheels which fit into the nicks in the bottom of the bobbin become worn, the bobbins will have a strong tendency to jump up at any time. If this jumping up should occur at the change of the lift, as it often does, the roving will wind under the bottom cone. (2). Again, if the slit in the bobbin which fits on the snugs just mentioned become worn, it is manifest that the same effect will take place as just mentioned. (3). If any of the small bobbin bevels be set too deeply in gear with the bobbin shaft bevels, then the larger bevels, being fast to the shaft, will often compel the smaller and loose bevels to jump up at the change of lift. Clearly this will cause running under.

SPIRAL SPRINGS ON REVERSING ROD.

The following improvement shows not only an excellent idea as applied to the reversing motion, but also indicates the trend of thought at the present time in connection with fly-frame improvements. It is the invention of Mr. R. Taylor, jun., of Messrs. Asa Lees & Co., Oldham. The central idea is the application of spiral springs to the reversing rod to assist its action, on very much the same lines as spiral springs are coiled round the long backing-off rod on self-actor mules.

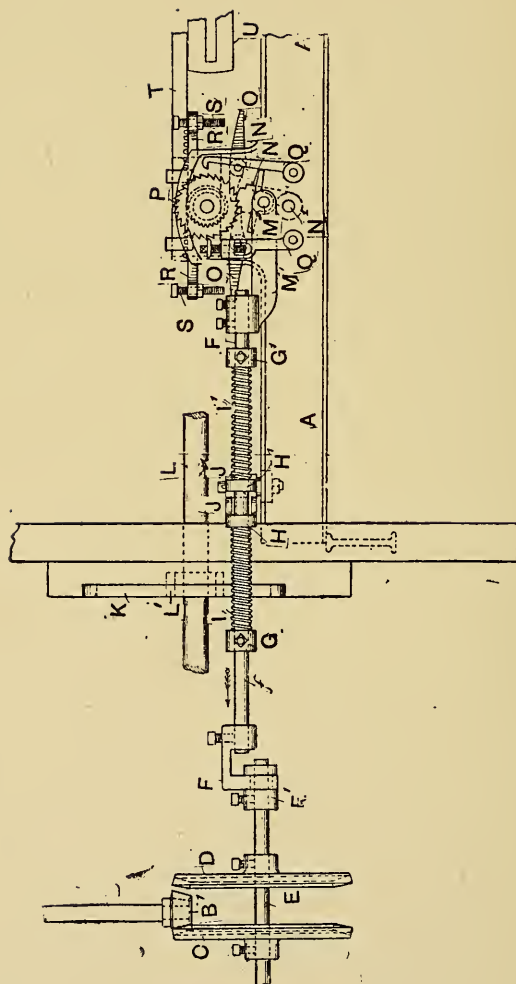


FIG. 43.

Fig. 43 clearly shows the improvements under notice. **A** designates the frame of the machine, **B** the upright shaft which drives the Jack-in-box (not shown), **B¹** is the small bevel strike pinion on bottom of upright shaft, **CD** are the lifter reversing bevels, which are fixed on the sliding shaft **E** and gearing alternately with **B¹**. Adjustably fixed on the sliding shaft **E** is a grooved collar **E¹**, the groove of which is engaged by the forked end of a bracket **F¹**, fixed adjustably on the reversing rod **F**, on which are also mounted two fixed collars **G G¹**, and two sliding collars **H H¹**. Between each pair of fixed and sliding collars is a spiral spring **I I¹** respectively, and these springs are alternately compressed by the action of an elbow lever **J**, which is fulcrumed at **J¹** to the frame. One end of this lever **J** is forked, and engages the reversing rod **F** between the two sliding collars **H** and **H¹**, and the other end enters a specially shaped slot in a bracket forming part of the reciprocating rack **K**, which is driven by the spur-wheel **L¹** on the lifter shaft **L**, and so actuates the bobbin lifting rail. When the rack **K** rises and falls the shape of the slot in the rack **K** causes the elbow lever **J** to be moved backwards and forwards on its fulcrum **J¹**, thereby actuating the sliding collars **H H¹**, and alternately changing first one and then the other of the springs **I I¹**. The reversing rod **F** is connected at **M¹** by an arm or extension **M** to a swivel lever **N**, which is fulcrumed at **N¹** to the frame **A**. The upper end of the swivel lever **N** has a projection **N²** on it, which is latched alternately by the building motion catches **O O¹**, which are mounted and actuated in the usual way. In the drawing are also shown the ratchet wheel **P**, the change motion ratchet levers **Q Q¹**, the rocking cradle **R**, the screws **S S¹** for releasing the catches **O O¹** respectively, the diminishing rod **T**, and the double slide **U**, which is fixed to the lifter rail, and so rises and falls with it. In the drawing the lifter reversing bevel **C** is shown in gear

with the bevel **B**; the elbow lever **J** is shown at the bottom of the slot in the rack **K**, whereby the sliding collar **H** has been moved to compress the spring **I** between it and the fixed collar **G**, and the reversing rod **F** is latched by the catch **O**. When the next change takes place the cradle **R** rocks, and by the screw **S** knocks the catch **O** off the projection **N**³, so releasing the reversing rod **F**; the spring **I** then immediately opens and forces the reversing rod **F** in the direction of the arrow, thereby taking the lifter reversing bevel **C** out of gear and putting the bevel **D** into gear with the bevel **B**¹ on the bottom of the upright shaft **B**. Before the next change takes place the spring **I** will have been charged by the movement of the slot **K**¹ on the rack **K** actuating the lever **J**, so that when the catch **O**¹ is knocked off, the reversing lever **F** will be moved by the force of the spring **I**¹ in the opposite direction; that is to say, back into the position shown on the drawing, with the reversing bevel **C** in gear, and the bevel **D** out of gear with the bevel **B**¹. By this arrangement of spiral springs upon the reversing rod, the anchor bar or diminishing rod **T** is relieved of the stress and strain usually put upon it by having to overcome the resistance of weights or springs connected directly to it.

CHAPTER VI.

ON CHANGING FROM TWIST-WAY TO WEFT-WAY, &c., &c.

Led on chiefly by a supposed secret given in Mr. Evan Leigh's work on cotton spinning, many spinners have at times changed some of their frames from twist-way to weft-way. The following is the method of performing such change:—

(1) Reverse the direction of motion of the jack-shaft or main shaft of the frame, by crossing the driving belt in the opposite direction. This will cause the spindles and bobbins and top cone and rollers, &c., to revolve in the opposite direction, which is required for the spindles and bobbins, but not for the other parts.

(2) Insert an extra carrier by the provision of a proper bracket between the main shaft and the top cone, which will cause the latter, and, consequently, the rollers, to move in the same direction as formerly.

(3) It may be that previously the frame had the bobbin or the flyer to lead, and it is desired to maintain such a condition. The sun wheel must, therefore, be caused to revolve the other way about, by inverting the plate wheel on the poker shaft, as described in changing from flyer to bobbin leading, or by whatever means are best suited to the style of frame being changed.

(4) If this is done, the reversing bevels must be attended to also, as described in the paragraph on changing from flyer to bobbin leading. There is a different method of

driving the sun wheel and reversing bevels on some frames, in which the change could be performed without affecting the direction of revolution of the small strike wheel.

(5) The pressers will all require to be changed to fresh ones of the other hand. It may be that previously the frame had the flyer to lead, and now it is desired not only to have the spindles running weft-way, but also to have the bobbin to lead. In this case it may be unnecessary to perform the 3rd, 4th, and 5th operations as above detailed. The sun wheel may be allowed to run the same way as before, although it will now be running the contrary way to the shaft. The presser fingers, which before were right for flyer leading, will now be right for bobbin leading, as the flyers and bobbins will all be revolving in the opposite direction.

A little reflection upon the foregoing remarks will show us that we may have frames with the spindles running twist-way, or to the right (in the same direction as the hands of a clock), or in the weft-way, or to the left. Also in each case we may have the flyer to lead or the bobbin to lead. The great bulk of the bobbin and fly frames now running have their spindles running twist way, and with the bobbin to lead. The author deems it advisable at this juncture to examine the theory on this subject propounded by the late Mr. Evan Leigh. To do this effectively it will be necessary to quote that writer's remarks on the subject.

"It is a common thing to turn the spindles of slubbing, intermediate, and roving frames all to the right or twist way. The effect of this may be best illustrated by endeavouring to make a rope of many strands all twisted one way. The tendency of such a rope would be to curl up and untwist itself; but if the strands are twisted one way when single, and the contrary way when doubled together, the rope will lie straight with the twist in it. Suppose then it is required to spin twist yarns from double

rovings, and there are slubbing, intermediate, and roving frames, with the ends or bobbins doubled behind the intermediate and roving frames as well as at the mules, the proper thing to do is to twist the slubbing to the left, the intermediate to the right, the roving to the left, and the mule to the right. The effect of this is, to a certain extent, to make the yarn like a cable, the fibres of cotton being interwoven together. Both the intermediate and the roving frames would work better and the mules spin better, and the yarn would be sounder and freer from crackers or weak places. More twist may also be got into it, and there will be less disposition to curl. When it is required to spin weft-wise, or to the left, with double roving in the mule, this proceeding must be reversed. It must be distinctly understood that it is of no use to reverse the spindles, except where a doubling takes place at the back, otherwise it is a two-fold loss of twist in the roving. Attention to the above cannot be too strongly impressed upon spinners, as the advantage to be derived from it is very great."

This theory of Mr. Evan Leigh's having been quoted at length, the author would like to examine it briefly. As a matter of fact it has been largely tried in different parts of the spinning districts, but, in our opinion, with by no means the extent of advantage claimed for it by its author. It is asserted that the intermediate and roving frames would run better, but our experiences do not support this allegation. In some cases, to the author's personal knowledge, the very reverse of this has been the case. There has been greatly increased difficulty in keeping the frames on after the change has been made. The stuff has not seemed to carry as well as before. Added to this, for a long time there has been the greatest difficulty in getting efficient tenters, as for a time the spindles revolving in the contrary direction require a different style of procedure in piecing broken ends. Indeed it would appear that this sole disadvantage

of having to have two sets of tenters more than discounts any supposed or real advantage obtained in the quality of the yarn. We give the result of our own examinations into the matter, and we do not forget that some practical men hold the opposite view.

The propounder of the theory makes a comparison with the different strands of which a rope is composed. Whilst this is a good illustration for showing the advantage of twisting doubling yarns the contrary way to which the single yarns are spun, it is scarcely of much value in the connection under discussion, on account of the twist being taken out of the cotton in the drawing rollers of the different machines. Let us examine this point more minutely. The following table has been prepared :—

Machine.	Hank.	Square Root.	Twist before going through next machine	Twist after going through rollers	Draft.
			per inch.	per inch	
Slubbing	·7	·837	1	...	...
Inter.....	1·74	1·319	1·58	·20	5
Roving...	5·20	2·28	2·74	·26	6
Mule.....	...	...	...	·32	8·5

It will be seen by above table that at the utmost not more than ·2 turns of twist per inch can remain in the strand made at the slubber after it has passed through the rollers of the intermediate frame. Also ·26 for the intermediate and ·32 for the roving after passing through the drawing rollers, with the assumed drafts and counts.

Similarly, for 60's out of double roving Egyptian cotton we might have hank slubbing $1\frac{1}{4}$, hank inter $2\frac{1}{2}$, and hank roving 10. The drafts would be about 4, 8, and 10 respectively, and the turns per inch $1\cdot0$, $1\frac{3}{4}$, and $3\frac{1}{4}$ respectively at the slubber, inter, and roving. This latter case would better meet Evan Leigh's stipulation of double roving, but the particulars would work out nearly the same as in above table.

Proceeding upon this line of reasoning, it scarcely appears that there can be much ground for assuming that the reversing method advocated can so greatly conduce towards making the yarn lie like a cable, through the influence of the twist in the single material. The author of this treatise has heard some spinners who have tried it assert that they get a somewhat better yarn; but having been at the trouble and expense of having one preparation changed, they, as a rule, do not see enough in the system to cause a complete changing thereto of all their frames. As a matter of fact, there are comparatively few firms that have the system at work at all, which fact speaks volumes. Also, it may be stated that the machine makers, as a significant fact, do not make many weft frames. To sum the matter up, we believe there is some slight advantage in the idea, but contend that the disadvantages are greater.

TO CHANGE FROM FLYER TO BOBBIN LEADING.

The conditions necessary to be fulfilled in converting a flyer leading frame into a bobbin leading seem to be surrounded by a considerable amount of perplexity in the minds of many practical men. There are two or three methods of doing it. Probably the best method is the one first described. Take the case of a frame in which there is an upright poker shaft which has three bevel wheels secured to it. The top wheel gears into and drives the sun wheel. One of the other two wheels is the small strike wheel, which drives the reversing bevels. The other wheel of the three is the plate wheel, which is driven from the bottom cone drum. We may note in passing that a method successfully adopted in some cases of overcoming the slight stretching of the roving attendant upon setting a

flyer leading frame on has been by the tenter slightly turning the bottom cone drum manually, prior to starting the frame.

(1) It will be understood that in a flyer leading frame the sun wheel revolves in the same direction as the main shaft of the frame. In a bobbin-leading frame the sun wheel revolves in the contrary direction to the shaft. It is quite clear, therefore, that the direction of revolution of the sun wheel must be reversed. This is done by inverting the plate wheel on the poker shaft, which is driven from the cone drums. Instead of having the teeth facing upwards, it is fixed with its teeth facing downwards, and with the cone end wheel gearing on its under side. A little reflection will show that, whilst this change is easily performed, it will also have the desired effect of reversing the motion of the sun wheel. On frames not containing the upright poker shaft, a wheel may be changed which is equivalent to the plate wheel.

(2) The flyer pressers, which for the flyer-leading frame have the presser finger, as at **A** Fig. 44, dragging behind the tubular flyer leg, will require to be changed, in order to

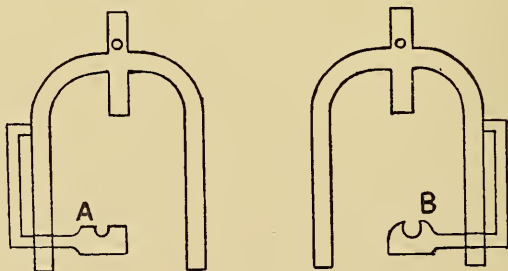


FIG. 44

have the presser fingers in advance of the flyer legs, to which the pressers are attached, as at **B** Fig. 44, that is, left-hand pressers will have to be used in place of right-hand pressers.

(3) The poker shaft having been made to revolve in the opposite direction, by inverting the plate wheel as just described, it will obviously have the effect of causing the small strike wheel to gear into the reversing bevels, and to revolve them in the opposite direction. Sometimes these reversing bevels have straight teeth, and in such cases this reverse method of driving will not matter. In other cases, the pair of reversing bevels have "skew" teeth, and there are right-hand pairs and left-hand pairs. In such cases it will be necessary to change the "hand" of the bevels. Supposing a pair of frames are being converted, then the bevels on one frame may be taken off and placed on the other frame, and *vice versa*.

(4) We will suppose that the frame is stopped with the lifter at the bottom, but the change-motion catch has just been released, and the lifter, with the ordinary running of the frame, is now ready for making its upward traverse. A little reflection will show that, because the small strike wheel has been reversed in its direction of motion, if the frame were now started the reversing bevels and lifter wheels would revolve also in the contrary direction, and would attempt to move the lifter rail still further downwards, instead of in an upward direction, as is essential. On many frames there is a lever which connects the reversing-bevel shaft to the change motion, and which can be so attached to the shaft as to allow of easy detachment and the connection being made at a different point or stud. This change should be effected, and will cause the reversing bevels to move one out of, and the other into, gear with the small strike wheel, with the result that when the frame is now started the lifter will move in the right direction. It would not be possible, by reversing the change motion manually, and having the frame stopped exactly half-way of the lift when the above changes were made, to manage without this last change. In some frames the small strike wheel shaft could be easily reversed

to the right direction again, and this will usually be the best plan. If the change motion were reversed by hand, thus setting the lifter off in the right direction, when the end of the lift was reached there would be a breakdown, because the wrong detent lever would be holding the top cradle. The best way is to alter the direction of the reversing bevel shaft revolution by turning the proper wheel round.

SECOND METHOD.

The second method the author can scarcely recommend.

(1) Reverse the direction of the main shaft or Jack shaft by crossing the driving belt the other way about.

(2) By this procedure all the parts of the frame, including the spindles, the bobbins, the rollers, etc., would be revolved the wrong way, if no steps were taken to prevent such contrary action. To prevent this, insert extra carrier wheels in the spindle and top cone driving trains of wheels; where more convenient, as it would be in the bobbin driving wheels or swing, instead of inserting an extra carrier, one carrier may be dispensed with. The latter is the course necessarily adopted in the swings with the new patent differential motions, in which the bush wheel on the shaft is made to revolve the same way as the shaft, which it seldom does with Holdsworth's motion. By the above procedure we should now have the sun wheel and the main shaft revolving in the opposite direction to each other, as is necessary for a bobbin-leading frame.

(3) The right-hand pressers must be changed for left-hand pressers, as in the first method. The poker shaft and reversing bevels and lifter will not have been interfered with.

INDICATORS.

On the front roller of a bobbin-and-fly frame it is customary to connect an indicator or counter, which registers the length of material that passes through the

front roller to any one spindle. By this means the amount of work produced from the frames can easily be ascertained, and the amount of wage due to the tenter per week thereby arrived at. Counting wheels or apparatus have been employed for a long number of years in connection with all kinds of mechanism. A familiar instance is in the gas meters used in houses. It may be said that generally there is only one guiding principle in this branch of mechanics, however varied may be the details of the separate parts.

SPINDLE-FOOTSTEP LUBRICATOR.

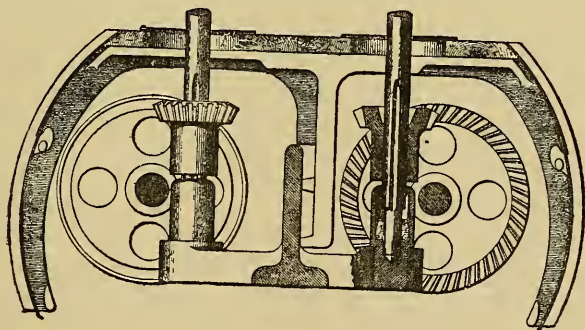


FIG. 45.

The spindles are the chief moving parts of a speed frame. There has been a strong tendency to provide better means of protection and lubrication for several of the machines employed in a spinning mill. Fig. 45 illustrates a recent improvement of some merit by Messrs. Dobson & Barlow, which has been designed to provide for the more efficient lubrication of bobbin-and-fly frame spindles. The footsteps are shown in front elevation and in section. It will be noticed that a groove is cut in the spindle extending from the shoulder to a point just above the top of the

spindle wheel. The spindle wheel itself is counter-sunk at the top, and the cavity thus formed serves as a receptacle for the lubricant. From this point the latter can flow freely down the groove made in the spindle and into the footstep. Clearly, if the spindle footsteps with this arrangement are ever allowed to become dry, there will be very gross carelessness on the part of somebody. There will be no need to lift up the spindle whilst oiling the footsteps, and the latter are also very effectively encased, so as to prevent dirt and fly from entering the oil chamber.

PATENT COMPENSATING "SWING."

It is well known to close students of the action of bobbin-and-fly frames that, inasmuch as the "swing" train of wheels belongs to what are termed epicyclic trains, there is an axial movement imparted to the bobbin shaft end wheels at every upward and downward movement of the lifter rail, in addition to that obtained from the ordinary driving due to the revolution of the wheels and their relative sizes. At one end of the lift there is a slight increase of speed imparted to the bobbins, whereas at the other end of the lift there is a slight decreasing of the speed of the bobbins. This is perhaps more so with the new differential motions than with Holdsworth's motion, as with some arrangements of the latter there are two carriers in the swing, whereas with the new motions there is usually only one carrier, owing probably to the first bobbin or bush wheel revolving with the main shaft in the new motions and against the main shaft with the old motion. Also, it is greater in frames with long lifts like slubbers than in frames with shorter lifts. In any case the practical defect is a slight thickening of the rove at one end of the lift, and a stretching of the rove at the other end of the lift. In Fig. 46 is shown a patent compensating swing which is designed to obviate these defects. Its object is

— COMPENSATING SWING —

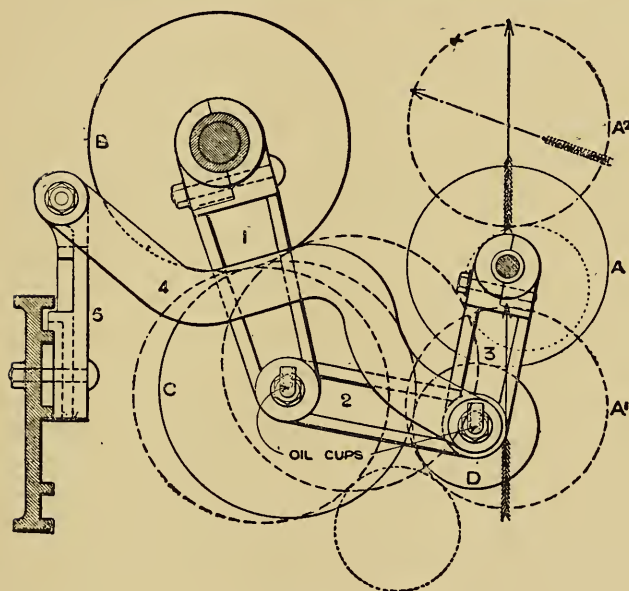


Fig. 46.

to prevent the "axial" movement of the bobbin shaft which takes place with the ordinary swing range.

Referring to the illustration, it may be taken to indicate both the new and old styles of swing. In an ordinary swing, consisting of a swing arm 1, and a fender bracket equivalent to links 2 and 3, the bobbin shaft wheel A, in moving from position A¹ to A², would turn on its axis from the full arrow point to point X during the first three-fourths of the lift, and from X to the point of the dotted arrow during the last one-fourth, producing an average stretch in the roving of $1\frac{1}{2}$ per cent. during the top one-fourth of the

down lift. By the improved patented swing the variation in the roving existing with the present swing is obviated, as it is found to be possible and practicable, by making the centre between 2 and 3 moveable instead of fixed, and controlling this centre by means of a link (4) pivoted some distance behind, and below the driving shaft **V** on the bracket 5, to make the rail travel up and down without producing any axial movement whatever of the bobbin shaft wheel, as shown by the full arrows. This swing is the invention of Mr. Shaw, of the firm of Messrs. Brooks and Doxey, who are the sole makers. The false movements of the bobbins with the old swing were demonstrated to the Author by the inventor with the aid of models. A minor improvement in connection with the swing, made by the same firm, is a curved slide, the upper surface of which corresponds to a curve struck from the swing-shaft centre, and which supports the outer end of the swing arm. The motion of the swing arm by this means is likely to be more steady in its traverse. This curved surface is accurately turned in the lathe, and is very frequently adopted by various makers of frames in one style or other.

For the benefit of his honour's students at Bolton Technical School during the winter session of 1896-7, the Author practically demonstrated the above point on a slubbing frame fitted with Holdsworth's differential motion. The fast bevel of the Jack-i'-th'-box was disconnected, and so also were the rollers. The frame was then started, and the loose compound wheel on the main shaft, or, in other words, the first driver of the swing-train of wheels, was held fast to be certain that it should have absolutely no rotary motion whatever. The bobbins being empty and the lifter having its maximum movement, and there being, in this case, only one carrier in the "swing," there was observed to be a rotary motion of the bobbins, approximating to about two-thirds of a revolution in one complete lift, due entirely to the rolling motion of

the swing-carrier round the loose compound wheel on the shaft. The frame had the bobbin to lead, and the tendency of this rotary motion was to slightly slacken the rovings during the ascent of the lifter, and to slightly tighten the rovings during the lifter's descent. In order to satisfy ourselves more fully as to the actual effect of this upon the rovings, the following calculation was made: The total coils of slubbing put on the bobbin were found by actual counting to be 70, and the circumference of the empty bobbin was approximately 5 inches, these particulars giving 350 inches put on in one layer of the empty bobbin. The gaining or slackening in the case under discussion having been shown to equal about two-thirds of a revolution of the bobbins in one lift, this would give $\frac{2}{3}$ of 5 inches, equal 3.3 inches total stretching or slackening to be divided out between 350 inches, which works out to every inch being pulled out to equal $1\frac{1}{10}$ inch in one case, and a corresponding reduction in the opposite case. This is not an abstruse algebraical demonstration, nor is it theorising in any shape whatever, but a plain, simple, and practical examination of the problem. Following out the experiment for an almost full bobbin, the Author counted 42 coils of slubbing in one lift, each coil containing 12 inches of cotton, and this giving 19×42 , equals 798 inches of cotton in one lift. The gaining and losing of the bobbins was observed to be such that it divided out into practically the same as for the empty bobbin. This can scarcely be regarded as being a very important factor in the production of a uniform and satisfactory roving, and we do not think any practical man need be alarmed about it. It must be remembered, however, that the gaining or losing is not distributed equally all through the lift, but is slightly more at the extremities of the lift than elsewhere.

Below will be found tables of hanks, speeds, and dimensions referring to bobbin and fly frames, which are

here produced through the great kindness of Messrs. Dobson & Barlow, the eminent Bolton firm of machine makers.

PRODUCTIONS OF FLY FRAMES.

SLUBBING FRAMES.

INDIAN AND LOW AMERICAN COTTON.

Speed of Spindles = 550 revolutions per minute.

Diameter of Full Bobbin = $5\frac{3}{4}$ in.

Weight of Full Bobbin = 30 oz.

Diameter of Front Roller = $1\frac{1}{8}$ in.

Lift = 10 in.

Time lost in Doffing, &c. = 14 minutes per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist per inch.	Hanks per Spindle per day of 10 hours.	Lbs per Spindle per day of 10 hours.	Hanks per week of $50\frac{1}{2}$ hours.	Percentage of Time lost in Doffing, &c.
0.4	189	2.9	0.821	9.4	23.51	53.1	29.2%
0.5	169	3.24	0.919	9.165	18.33	51.78	22.8%
0.6	153	3.55	1.006	8.898	14.83	50.27	18.4%
0.7	143	3.84	1.087	8.52	12.17	48.18	15.1%
0.8	134	4.1	1.162	8.2	10.25	46.33	12.7%

SLUBBING FRAMES.

AMERICAN AND LOW EGYPTIAN COTTON.

Speed of Spindles = 500 revolutions per minute.

Diameter of Full Bobbin = $5\frac{1}{2}$ in.

Weight of Full Bobbin = 28 oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 10 in.

Time lost in Doffing, &c. = 14 minutes per set.

0·8	142	3·5	0·894	9·368	11·71	52·93	15·6%
0·9	134	3·72	0·948	9·054	10·06	51·15	13·4%
1·0	127	3·92	1·000	8·75	8·75	49·4	11·7%
1·1	121	4·11	1·048	8·49	7·72	47·98	10·3%
1·2	116	4·3	1·095	8·23	6·86	46·5	9·1%

SLUBBING FRAMES.

GOOD EGYPTIAN AND SEA ISLAND COTTON.

Speed of Spindles=400 revolutions per minute.

Diameter of Full Bobbin= $5\frac{1}{2}$ in.

Weight of Full Bobbin=26 oz.

Diameter of Front Roller= $1\frac{2}{3}$ in.

Lift=10in.

Time lost in Doffing, &c.=14 minutes per set.

0·7	158	2·52	0·585	10·6	15·14	59·9	21·7%
0·8	148	2·7	0·625	10·32	12·91	58·3	18·5%
0·9	139	2·86	0·664	10·02	11·14	56·6	16·0%
1·0	132	3·02	0·7	9·75	9·75	55·0	14·0%
1·1	126	3·17	0·734	9·46	8·6	53·46	12·3%
1·2	121	3·3	0·766	9·2	7·67	52·0	11·0%
1·3	116	3·44	0·798	8·93	6·87	50·45	9·8%
1·4	112	3·57	0·828	8·7	6·22	49·1	8·9%
1·5	108	3·7	0·857	8·475	5·65	47·8	8·1%

INTERMEDIATE FRAMES.

INDIAN AND LOW AMERICAN COTTON.

Speed of Spindles=700 revolutions per minute.

Diameter of Full Bobbin= $4\frac{1}{2}$ in.

Weight of Full Bobbin=24 oz.

Diameter of Front Roller= $1\frac{1}{3}$ in.

Lift=10in.

Time lost in Doffing, &c.=14 minutes per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist per inch.	Hanks per Spindle per day of 10 hours.	Lbs. per Spindle per day of 10 hours.	Hanks per week of 56½ hours.	Percentage of Time lost in Doffing, &c.
0·8	198	3·78	1·07	10·968	13·71	61·92	21·0%
0·9	187	4·00	1·137	10·67	11·85	60·28	18·4%
1·0	176	4·24	1·2	10·38	10·38	58·64	16·0%
1·1	169	4·44	1·258	10·13	9·2	57·24	14·3%
1·2	162	4·63	1·314	9·86	8·22	55·73	12·7%

INTERMEDIATE FRAMES.

AMERICAN AND LOW EGYPTIAN COTTON.

Speed of Spindles = 680 revolutions per minute.

Diameter of Full Bobbin = $4\frac{1}{2}$ in.

Weight of Full Bobbin = 22 oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 10 in.

Time lost in Doffing, &c. = 14 minutes per set.

1·2	140	4·98	1·27	9·46	7·89	53·5	13·4%
1·4	130	5·38	1·376	9·01	6·44	50·84	10·9%
1·6	122	5·73	1·467	8·59	5·37	48·59	9·1%
1·8	115	6·08	1·554	8·22	4·57	46·47	7·7%
2·0	111	6·36	1·62	7·96	3·98	44·97	6·7%
2·2	105	6·75	1·72	7·59	3·45	42·88	5·8%
2·4	99	7·03	1·796	7·32	3·05	41·35	5·1%
2·5	97	7·18	1·832	7·17	2·87	40·53	4·8%

INTERMEDIATE FRAMES.

GOOD EGYPTIAN AND SEA ISLAND COTTON.

Speed of Spindles = 650 revolutions per minute.

Diameter of Full Bobbin = $4\frac{1}{2}$ in.

Weight of Full Bobbin = 20 oz.

Diameter of Front Roller = $1\frac{3}{8}$ in.

Lift = 9 in.

Time lost in Doffing, &c. = 14 minutes per set.

1'50	157	4'12	0'954	11'11	7'41	62'77	13'8%
1'75	146	4'45	1'03	11'04	6'31	61'37	11'7%
2'00	136	4'75	1'1	10'4	5'2	58'76	9'8%
2'25	129	5'04	1'17	10'08	4'48	56'95	8'3%
2'50	122	5'31	1'232	9'67	3'87	54'66	7'2%
2'75	116	5'58	1'293	9'29	3'38	52'48	6'3%
3'00	111	5'83	1'35	9'0	3'0	50'85	5'6%
3'25	107	6'04	1'4	8'8	2'71	49'77	5'0%
3'50	103	6'26	1'45	8'47	2'42	47'85	4'5%

ROVING FRAMES.

INDIAN AND LOW AMERICAN COTTON.

Speed of spindles = 1,100 revolutions per minute.

Diameter of Full Bobbin = $3\frac{1}{2}$ in.

Weight of Full Bobbin = 11 oz.

Diameter of Front Roller = $1\frac{1}{8}$ in.

Lift = 7 in.

Time lost in Doffing, &c. = 13 minutes per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist per inch.	Hanks per Spindle per day of 10 hours.	Lbs. per Spindle per day of 10 hours.	Hanks per week of 56 $\frac{1}{2}$ hours.	Percentage of Time lost in Doffing, &c.
1'75	155	7'06	2'0	9'29	5'31	52'5	16'0%
2'00	146	7'5	2'122	8'84	4'42	49'94	13'9%
2'25	138	7'95	2'25	8'55	3'8	48'3	11'9%
2'50	131	8'3	2'37	8'25	3'3	46'61	10'4%
2'75	125	8'79	2'487	7'947	2'89	44'9	9'1%
3'00	119	9'18	2'6	7'71	2'57	43'56	8'1%
3'25	115	9'54	2'7	7'47	2'3	42'23	7'2%
3'50	111	9'9	2'8	7'24	2'07	40'93	6'5%
3'75	107	10'24	2'9	7'05	1'88	39'83	5'9%
4'00	103	10'6	3'0	6'8	1'7	38'42	5'4%

ROVING FRAMES.

AMERICAN AND LOW EGYPTIAN COTTON.

Speed of Spindles = 1,050 revolutions per minute.

Diameter of Full Bobbin = $3\frac{1}{2}$ in.

Weight of Full Bobbin = $10\frac{1}{2}$ oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 7 in.

Time lost in Doffing, &c. = 13 minutes per set.

2'0	151	6'94	1'767	9'84	4'92	55'59	16'2%
2'5	135	7'76	1'976	9'25	3'7	52'26	12'2%
3'0	123	8'5	2'165	8'67	2'89	48'98	9'5%
3'5	114	9'15	2'33	8'246	2'356	46'59	7'7%
4'0	107	9'8	2'5	7'76	1'94	43'84	6'4%
4'5	101	10'4	2'65	7'38	1'64	41'69	5'4%
5'0	95	10'97	2'795	7'05	1'41	39'83	4'6%

ROVING FRAMES.

GOOD EGYPTIAN AND SEA ISLAND COTTON.

Speed of Spindles = 900 revolutions per minute.

Diameter of Full Bobbin = $3\frac{1}{2}$ in.

Weight of Full Bobbin = $10\frac{1}{2}$ oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 8 in.

Time lost in Doffing, &c. = 13 minutes per set.

4'0	104	8'64	2'2	7'6	1'9	42'94	6'2%
4'5	98	9'15	2'33	7'2	1'62	40'68	5'3%
5'0	93	9'66	2'46	6'9	1'38	38'98	4'5%
5'5	88	10'13	2'58	6'65	1'21	37'6	4'0%
6'0	85	10'58	2'694	6'36	1'06	35'93	3'5%
6'5	82	11'0	2'804	6'11	0'94	34'52	3'1%
7'0	79	11'42	2'91	5'88	0'84	33'22	2'8%

JACK FRAMES.—AMERICAN COTTON.

Speed of Spindles = 1,150 revolutions per minute.

Diameter of Full Bobbin = $2\frac{3}{4}$ in.

Weight of Full Bobbin = 9 oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 7in.

Time lost in Doffing, &c. = 13 minutes per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist per inch.	Hanks per Spindle per day of 10 hours.	Lbs. per Spindle per day of 10 hours.	Hanks per week of 56½ hours.	Percentage of time lost in Doffing, &c.
4.0	133	8.63	2.2	9.4	2.35	53.1	9.0%
4.5	125	9.13	2.33	9.0	2.0	50.85	7.7%
5.0	119	9.66	2.46	8.65	1.73	48.87	6.6%
5.5	113	10.13	2.58	8.3	1.51	46.89	5.8%
6.0	108	10.6	2.7	7.98	1.33	45.0	5.1%
6.5	104	11.0	2.8	7.73	1.19	43.67	4.6%
7.0	100	11.42	2.91	7.42	1.06	41.9	4.1%
7.5	97	11.82	3.01	7.27	0.97	41.0	3.7%
8.0	94	12.2	3.11	7.04	0.88	39.77	3.4%

JACK FRAMES.—EGYPTIAN COTTON.

Speed of Spindles = 1,120 revolutions per minute.

Diameter of Full Bobbin = $2\frac{3}{4}$ in.

Weight of Full Bobbin = 8 oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 7in.

Time lost in Doffing, &c. = 13 minutes per set.

9.0	105	10.6	2.7	7.915	0.879	44.7	3.8%
9.5	103	10.87	2.77	7.737	0.814	43.71	3.5%
10.0	100	11.17	2.845	7.54	0.754	42.6	3.2%
10.5	98	11.38	2.913	7.41	0.704	41.87	3.0%
11.0	95	11.7	2.98	7.238	0.658	40.89	2.8%
11.5	93	11.97	3.05	7.089	0.616	40.05	2.7%
12.0	91	12.21	3.117	6.948	0.579	39.21	2.5%
12.5	89	12.48	3.18	6.818	0.545	38.47	2.3%
13.0	88	12.72	3.24	6.7	0.515	37.86	2.2%
13.5	86	12.96	3.305	6.58	0.487	37.17	2.1%
14.0	84	13.2	3.366	6.468	0.462	36.5	2.0%

JACK FRAME.—SEA ISLAND COTTON.

Speed of Spindles = 1,050 revolutions per minute.

Diameter of Full Bobbin = $2\frac{1}{2}$ in.

Weight of Full Bobbin = 6 oz.

Diameter of Front Roller = $1\frac{1}{4}$ in.

Lift = 6 in.

Time lost in Doffing, &c. = 13 minutes per set.

15·0	72	14·4	3·677	5·535	0·369	31·27	2·2 ⁰ / ₀
15·5	71	14·68	3·739	5·457	0·352	30·79	2·0 ⁰ / ₀
16·0	70	14·92	3·8	5·364	0·335	30·28	1·9 ⁰ / ₀
16·5	69	15·14	3·857	5·296	0·32	29·88	1·8 ⁰ / ₀
17·0	68	15·37	3·916	5·22	0·307	29·49	1·7 ⁰ / ₀
17·5	67	15·63	3·98	5·145	0·294	29·07	1·7 ⁰ / ₀
18·0	66	15·82	4·03	5·082	0·282	28·7	1·6 ⁰ / ₀
18·5	65	16·04	4·085	5·011	0·271	28·33	1·5 ⁰ / ₀
19·0	64	16·25	4·14	4·96	0·261	28·0	1·5 ⁰ / ₀
19·5	63	16·49	4·2	4·88	0·25	27·57	1·4 ⁰ / ₀
20·0	62	16·68	4·248	4·83	0·24	27·29	1·3 ⁰ / ₀

SLUBBING FRAMES.

Diameters of the spindles, $\frac{1}{8}$ in. or $\frac{7}{8}$ in.; lift of the bobbins, 10 in., 11 in., or 12 in.; distance of the spindles from centre to centre, 8 in., $8\frac{1}{2}$ in., 9 in., $9\frac{1}{4}$ in., $9\frac{1}{2}$ in., 10 in., or $10\frac{1}{4}$ in., which is equivalent to four spindles in 16 in., 17 in., 18 in., $18\frac{1}{2}$ in., 19 in., 20 in., or $20\frac{1}{2}$ in.

INTERMEDIATE FRAMES.

Diameters of the spindles, $\frac{3}{4}$ in., $\frac{1}{2}$ in., or $\frac{7}{8}$ in.; lift of the bobbins, 9 in., 10 in., or 11 in.; distance of the spindles from centre to centre, $5\frac{1}{2}$ in., $5\frac{3}{4}$ in., 6 in., $6\frac{1}{2}$ in., or 7 in., which is equivalent to six spindles in $16\frac{1}{2}$ in., $17\frac{1}{4}$ in., 18 in., $19\frac{1}{2}$ in., or 21 in.

ROVING FRAMES.

Diameters of the spindles, $\frac{5}{8}$ in., or $\frac{11}{16}$ in.; lift of the bobbins, 7in., or 8in.; distance of the spindles from centre to centre, $4\frac{3}{4}$ in., 5in., $5\frac{1}{8}$ in., $5\frac{1}{4}$ in., or $5\frac{1}{2}$ in., which is equivalent to eight spindles in 19in., 20in., $20\frac{1}{2}$ in., 21in., or 22in.

JACK FRAMES.

Diameters of the spindles, $\frac{9}{16}$ in., $\frac{5}{8}$ in., or $\frac{11}{16}$ in.; lift of the bobbins, 5in., 6in., or 7in.; distance of the spindles from centre to centre, 4in., $4\frac{1}{4}$ in., $4\frac{3}{8}$ in., or $4\frac{1}{2}$ in., which is equivalent to eight spindles in 16in., 17in., $17\frac{1}{2}$ in., or 18in.

It must be noted that the gauge of the steel spindles as given above includes both back and front rows of spindles. It is the practice to place the spindles of the back row in a central or almost central position behind and between those of the front row as under—



This practice, whilst giving the maximum number of spindles in a given length of frame, affords greater facilities for doffing, cleaning, repairs, and other such things. It would be an evil to have the spindles placed exactly behind each other, as for one thing the length of roving reaching the roller nip to the flyer top would be so much greater for the front row than the back, thus putting a comparatively greater strain on the roving in the former case than in the latter.

EXTRAS.

Such things as the following are often regarded as extras, or, at any rate, as optional with the purchaser whether he shall have them applied or not:—

Loose boss top rollers to the front line; bottom rollers case-hardened all over, or in the necks and squares only; single boss rollers to the roving and jack frames; Mason's

long collars; indicators; bobbin boxes; round clearers with traverse motion and heavy self-weighted back top rollers in place of cast-iron flats and ordinary rollers; polished-steel dividing plates; double-centrifugal press fliers. Most firms have special patents, which are optional with the buyer whether he shall have or not. Many of these are described elsewhere in this treatise. Such things, for instance, as Taylor's cone-releasing motion (Asa Lees); compensating swing (Brooks & Doxey); self-lubricating footsteps with loose brass bottoms (Dobson & Barlow). In some cases also the patent differential motions are optional with the purchaser.

It may be remarked here that the differences between frames as now made and as made 30 or 40 or more years ago consist entirely in matters of detail such as the following, in addition to those just enumerated:—

The parts are better proportioned, and jointings and distances planed and milled accurately and to template; large diameter cast-iron studs; improved motions for tapering the bobbins; for winding back the cone belt; for raising or lowering the cone drums; for knocking the frame off when bobbins are full, and so on. The cone belt is made longer, and various contrivances have recently been brought out for giving a more perfect action of this belt. The top rails are balanced better, and the various shafts made stronger. The spindles, fliers, and rollers, etc., are of superior construction.

OILING AND CLEANING.

A regular system of oiling and cleaning is of the highest importance. Carders should insist upon some definite routine of having these things done, in order that they can themselves better observe whether the tenters are duly carrying out their instructions. They will receive the benefit in the machinery lasting longer, and in its more efficient working. The amount of cleaning and oiling

required will always vary somewhat, according to the kind of cotton used, the hank roving, etc., but the following may be taken as an approximate basis upon which to establish a working system.

Drawing Frames.—The principal bearings may be oiled twice a day, and bearings of minor importance once a day. The gearing teeth may be greased or oiled occasionally, and will be all the better for it, although some people do not believe in it. The fluted rollers may be taken out and scoured, say, every six months, and, of course, at the same time the roller necks and stands well picked and cleaned. Some carders prefer to inlay the roller squares with tallow, whilst others prefer to have them oiled regularly.

Bobbin-and-Fly Frames.—As in the case of the drawing frames, all the principal bearings should be oiled twice a day, and minor bearings once a day. The collars should be oiled twice a day, and the spindle footsteps once a month. The latter would require more oiling, but a good deal of oil runs off the collars, &c., down into the footsteps. In the opinion of the author it is preferable to oil the lifter chains occasionally, and also to grease and oil the teeth of all the principal wheels. In the long run a saving will be effected by this practice. The fluted rollers should be taken out and thoroughly scoured twice a year, and at the same time all the stands and necks thoroughly well cleaned and picked. The flys ought to be picked about twice a day, or every time the frames doff in some cases. Some carders will have them picked between doffings as well, this matter being largely affected by the counts of the hank roving being made.

SUMMARY OF FRAME AILMENTS.

Speaking generally it may be said that the ailments of a bobbin-and-fly frame may be divided into about five parts.

(1) If anything be wrong with the action of the lifter all along the frame, it probably results from some fault in the

various connections which control the reciprocating movement of the lifter. The shafts and the wheels from the small strike wheel to the lifter racks may be examined first of all, and also the lifter itself. Individual bobbins may be spoiled from causes elsewhere enumerated. In cleaning, a tenter will sometimes release the catch of the building motion, and the strike wheel, will be left out of gear thereby.

(2) If anything be wrong with the roving as it issues from the rollers, it is probable that the fault originates from the draft wheels, either in the four wheels that drive the back roller, or the three wheels which drive the middle roller from the back. Dirt may be in the wheels, or one of the pins may be broken, or the wheels badly geared, or some of the parts may be rubbing against something else, or the end caps screwed down so as to bind the middle and back rollers. If the large wheel at the end of the front roller, or the wheel that drives it from the top cone shaft came loose, then the rollers would stop altogether. The roller traverse might have become disarranged so as either to affect the whole of the rovings, or a portion only may have got wrong. Yet, again, the rollers may be set too close, causing the fibres to be broken, and the stuff to spew through the rollers; or they may be set too far away, causing the stuff to issue from the rollers in an unevenly drawn and cloudy condition. The rollers themselves may want re-covering. All the foregoing is pre-supposing that the rovings in the creel as made by the last machine are all right, which may not be the case, and should be noticed first of all. Occasionally we have known an application of varnish to the front leather rollers make a wonderful improvement in the work.

(3) The winding may be wrong, *i.e.*, the ends may be too tight or too slack, or irregular in tension. The fault in these cases generally rests in the cone-drum connections. The cone belt may be too slack or too tight, or badly

pieced. There may be a wrong ratchet wheel on, causing the cone belt to be on an improper diameter of the bottom cone. The cone end wheel, or the Jack wheel that drives the sun wheel, may not be the correct size. Some of these wheels may be badly geared, or have become loose on their shafts or studs. We should be particularly careful to set the catches and button for holding and releasing the rack-wheel exactly to *half-a-tooth* of the wheel, or otherwise the ends at one change will be slack, and at the other change be tight. An exceedingly skilful person, however, might possibly put these a trifle out, with the object of compensating for loss and gain in the lifter, although we by no means recommend such a practice.

(4) If all the bobbins or all the spindles stopped and other frame parts kept revolving, probably the wheels at the frame end, on the ends of the spindle or bobbin shafts, would be broken or loose, or the same defect might exist in the wheels that drive the bobbins or spindles from the frame shaft. If only the wheel on the end of the front spindle shaft or the front bobbin shaft were wrong, then only the front row of spindles or bobbins would be affected. The spindle and bobbin rails and shafts are generally divided into three sections, and if anything ailed the bobbins or spindles in one or two sections only, then the couplings of the sections should be immediately examined.

(5) If the coning or ending of the bobbins be defective, or the changes be faulty, we may re-set the tapering rod, or put a fresh coning wheel on, or attend to the catches and Jack screws belonging to the change motion, and also the chains, springs, and nuts belonging to the latter.

BALANCING OF THE LIFTER.

Several years after the introduction of Holdsworth's Differential Motion, what was considered at the time a great improvement in the method of operating the lifter was brought about by the application of vertical screws to

the lifter rails instead of racks and pinions, square thread internal screws being secured in the lifter rail, midway between the front and back lines of bobbins. The vertical external screws propelled the lifter rail after the style that a quadrant nut, or shaper nut, on a self-acting mule is moved about, motion being given to the vertical screws by bevel wheels. It was alleged that the racks and pinions caused the lifter to dwell a little at each change, owing to backlash in changing with such a slow motion, and causing over-stretched and slattered rovings. By the application of the screws the rail was allowed to rest with a portion of its weight on the threads, thereby obviating dwell at the changes. One chief reason for this principle being abandoned was on account of excessive wear in the threads. This was aggravated by the screws being made of wrought iron and the bushes of brass. Improvements were effected in some cases by having both screws and bushes made of cast iron, and more perfectly balancing the rail.

Practical men are well aware of the beneficial results secured by having cast iron working with cast iron. If great care is taken at first to keep such bearings well saturated with oil, the uniformly porous nature of the metal takes in the oil like a sponge, and afterwards the bearing surfaces attain a high polish like glass, becoming almost as hard and durable. Whatever be the reason, the screw-lift has long been discarded in favour of the rack and pinion method. The defect, however, of backlash at the changes is very simply overcome. The bobbins, and consequently the lifter, increase in weight all through the set, on account of the filling of the bobbins, and this fact tends to prevent perfect balancing of the lifter. By making the weights, or else the lifter, the heavier of the two, so that the teeth of the racks and pinions are always biting one way, the evil of backlash is obviated. Recently still more perfect action has been secured by cutting the teeth of the racks and pinions out of the solid.

At various times in our experience we have known lifter rails to come crashing down the spindles with more or less disastrous results to the parts of mechanism connected therewith. This may be caused in the following manner:—The tenter, when cleaning, partially and accidentally changes the building motion and leaves the small strike wheel disconnected from both the reversing bevels. The restraining power of the wheels is thus taken from the lifter, and the latter then—especially if the bobbins be nearly full—rather more than overbalances the lifter weights, with the result that the lifter drops down when the frame is started. In our opinion the construction of the frame should always be such as to render such an occurrence practically impossible, and it must not be supposed that even now such a tumble down of the lifter always takes place when the reversing bevels are disconnected.

CHAPTER VII.

HOW TO PUT A BOBBIN AND FLY FRAME UP.

We have first to establish a correct **centre line** to which we may set our roller beam. The roller beam may be said to largely rule everything else as regards setting at a proper angle. Providing we are intending fixing our frame to work alongside of another frame that is already put up, the best way to get our centre line will be to take it from the roller beam of the frame already working. This may be done by measuring equal distances of the required dimensions from either end of the roller beam upon the floor. The two chalk marks made on the floor may be connected by a string being extended from one to the other. Having rubbed the string thoroughly well with chalk, it may be raised and dropped on the floor again several times until a distinct chalk mark is made from one end of the frame to the other. A readier method, and certainly quite as accurate a method, is to carefully measure from one roller beam to the other, as the frame ends and roller beam of the new frame are being roughly put together at first. This measurement should be repeated five or six times on the length of the frame, and equal distances maintained at all points. This is probably the best method of the lot, where it is practicable. It is a somewhat more difficult thing to get the centre line for the roller beam when there is not another frame to go by, and possibly the wall is too crooked to work from. Generally the best plan in such a

case will be to work from the line shaft. This is generally placed over the top of the frames, at right angles to the roller beam. It may extend almost over the frame ends, and a half-crossed belt be used to drive the jack shaft of the frame. It is sometimes, however, placed some distance away from the frame ends, and a longer belt is thereby obtained, although a pair of guide pulleys are rendered necessary. This is probably the better plan for a low room. When getting centre line from line shaft, drop a plumb-bob with a pointed end from the shaft, and very carefully make a mark at the exact point at which this plumb-bob touches the floor. Drop the plumb-bob again a few feet away from the other place, and again carefully mark the floor where the plumb-bob touches it. A chalk mark may now be made connecting these two points either by a chalked string as just described, or some other means. A chalk line may now be extended the whole length of the frame, at right angles to the line just obtained. The roller beam can now be set parallel to the last made chalk line. One of the chief things we have to do in fixing the position of the roller beam is to put it at a **proper distance** from the next frame to it, or from the wall, as the case may be. Enough space should be left for the tenter to attend to her creeling, etc., at the back of the creel, and to perform such operations as doffing, etc., at the front of the frame. It very much impedes a tenter in the exercise of her duties when she is cramped for room in the back and front alleys. A fair distance from the edge of one roller beam to the edge of another may be about 50 inches in the front alley, and about the same in the back alley. It is as well if intermediates can have a little more space than roving frames, on account of the larger bobbins of the former, and the greater frequency of doffing, etc. The back alleys of slubbing frames have, of course, to be made right for containing the drawing frame cans. The distances above

given will probably leave about 22 inches between feet of frame gearing ends, and 30 inches between feet of outer ends of the frames. Also, say, about 28 inches from one front-lifter plate to another. These dimensions, of course, vary a little with different makers.

Having decided by what method we shall get our roller beam linable, and drawn a centre line, if such be necessary, the next thing is to get all the necessary material laid in position, just ready to hand. The two frame ends, the roller beam, the spring pieces, the lifter and spindle rails, etc., should be quite handy. It facilitates the work of the person putting up a frame very much to have things all to his hand. A good, intelligent labourer is a boon to a fitter any time. The roller beams, lifter rails, and spindle rails are almost invariably in three parts, which have to be bolted together. In each case these parts should be marked one, two, three, and number one is always next to the gearing end of the frame. The three parts are compelled to go in their own places, and cannot be changed. Having got the three pieces of roller beam and the two frame ends specially handy, the gearing end can be lifted up, and then held by—say one man. The pieces of roller beam are very heavy, as the author very well knows, having been in at carrying them about. They are made heavier by the roller stands being generally attached to them. Several men therefore may lift up number one piece of beam, and rest one end upon a special projection which is cast upon the inner surface of the frame end. At the same time the spring piece nearest to the other end of this piece of roller beam must be put in its place, and the frame end and roller beam secured together by strong bolts. These bolts, however, are not to be finally screwed up at present.

This portion of roller beam may now be set linable by measuring from roller beam of another frame, or by other means, although this is not to be a final setting, and it must be further noticed that the intermediate spring

pieces are not yet to be put in their places. The second piece of beam must now be lifted up and one spring piece put under either end of it, and bolts inserted to connect the first and second pieces of beam together. This second piece must also be set linable. The third piece of roller beam will now be lifted up as well as the other frame end at the same time. This third piece will rest on a spring piece at one end, and upon a ledge of the frame end at the other extremity. It will also be bolted to number two piece and to the second frame end, and be made linable. The labourers may now be all sent away for the present, excepting one, whose help is necessary to fetch and carry things as the fitter requires, and to render other necessary assistance.

Before putting anything else together a little **levelling up** should now take place. We may begin with the gearing frame end and place a wooden packing under, say three-quarter inch or one inch thick. With very unlevel floors more wooden packing may be needed. The spirit level may be placed on top of frame end, and pieces of brown paper packing added to the wooden packing, just according to the reading of the spirit level, until the mercury shows in the centre of the level. This part having been made right, we can attend to number one piece of roller beam. As it is a new frame the stands will be correct with each other, and to get roller beam level we might either use a string extended across the front stands or simply take notice of the spiral level, or do both.

Adopting the latter method, the fitter up can be at the front of frame and watch the spirit level whilst the labourer is at the back of the frame with a pinch-bar. The latter can then, by the aid of the bar, raise or lower the top part of spring pieces already at work, in specially prepared slots, to whatever extent and in whatever direction may be indicated to him by the fitter. In some cases, instead of slots at the back, there are setting screws. The beam

needs to be correct with the spirit level placed crossways and also lengthways of it. As we have shown, it is kept linable from another roller beam or from a centre line. Although the three pieces of beam are bolted together, yet the bolts have not yet been screwed up tight, and so the second piece is not disturbed whilst setting the first. The second and third must now be set similarly to the first, and the bolts made tight, both at frame ends and to connect one part to another. The other frame end must also be set with spirit level and wood and paper packings. We may now put all the other spring pieces to their places, excepting one, and accompany this by again levelling the roller beam up at every spring piece. The roller beam will now probably need no further setting.

The one spring piece that has been hitherto left out, is that next the gearing-frame end. It has been left out in order to facilitate the fixing up of the "coupling beam," that is, the strong cross girder or beam near the end of the frame, which helps to support much of the gearing. If the spring piece in question had been fixed up previously, it would be difficult to fix up this "coupling-up beam," at any rate, in some frames. Both these parts, however, may now be secured in their places. Before leaving the machine shop this beam has been fixed in its place and marks have been cut to show exactly where it should be placed at either end. It should, however, be set with the spirit level on its top-planed surface to secure additional accuracy. A portion of the gearing will probably be attached to this beam when it comes from the machine shop, and it need not be taken off.

We may now adjust the "rack motion," or "building motion," to its place. This need not be the difficult operation that we might think it would be. Almost the whole of the apparatus arrives at the mill fitted up and connected to projections cast on a long girder or cross beam. Sometimes this projection is simply bolted to the girder,

This girder extends from one spring to another, and has its proper position marked out on either spring piece, but the spirit level had also better be put upon its top planed surface when setting it. The "hanger bar" on one side of the "building motion" and the reversing rod on the other side of it, are perhaps the only parts that require attaching to the building motion. It would be quite impracticable to have these two rods attached to their places when the frame came new to the mill, and they need not be set at present. If the "change motion" came to the mill absolutely in pieces, it would take more time to get the frame up, and the small parts would not always be adjusted with the same accuracy. Before putting the spindle and lifter rails in their places, we may next turn our attention to the important duty of setting the **spring pieces**. Perhaps more care, if possible, is required in setting these than anything else about the frame. We may first extend a string from one end of the frame to the other along the front roller stands. Spindle banding is often used, but it is preferable to use brown string with less stretching in it. A piece of wood, say $\frac{1}{8}$ inch thick, or brown paper may be put under the string on the roller stand at each end of the frame. This is to keep the string just nicely clear from all the other front stands. The string should be pulled very tight, and should extend along the stands as near their centres as possible. The setting of the spring pieces in some respects is to be compared to setting the slips of a mule, inasmuch as the lifter, in its reciprocating motion, is controlled by the slides of the spring pieces.

SPRING PIECES.

The spring pieces on a bobbin and fly frame, however, play a much more important part than the spring pieces on a mule, and need much more care in setting. In the mule the spring pieces have little or nothing to do with the head-

stock gearing, the slips, the carriage, &c. The chief necessity for great care and accuracy in the setting of the spring pieces arises out of the fact that in them are formed the vertical slides which guide the reciprocating motion of the lifter rail. They also form the supports for the spindle rails, the roller beam, the lifter shafts, much of the gearing, &c. When compared with the mule we might say they act as slips, spring pieces, and headstock frame all in one. The chief desideratum to be secured in setting them is to get them exactly perpendicular, so that the racks working in them—and, therefore, the lifter, which is connected to the racks by suitable brackets—shall have as free and easy a movement as possible. This string we have fixed will indicate whether we get any one spring piece too much forward or backward bodily; also, whether we get the spring piece, and, therefore, the roller beam, too high. The fact of being bolted to the roller beam largely assists in obtaining correct position for spring pieces. If any one were bodily too much on one side, the various corners, &c., for lifter rail would probably be difficult to adjust. In order to set the spring pieces vertically, a guage such as shown on Figs. 47 and 48 may be used. Upon **A B** a small spirit level is placed. The piece **E F** is fitted in the slide and made tight, unscrewing the set screw **E** to a sufficient degree. The mercury will then show whether the back end of the spring piece is too low or high, and adjustments can be made accordingly. The spirit level can also be placed across the other way, viz., from **C** to **D**, the mercury will then clearly indicate whether the spring piece or slide is tilted to any one side at its top edge. The guage shown is capable of swivelling about on the pin **H**. The racks should fit easily and freely in the slides, and not be liable to bind the spindles at certain parts of the lift, as is sometimes the case. The latter is a serious evil, and tends to make the frame run very heavily. Sometimes the brackets which connect the lifter to the racks have not their fitting surfaces

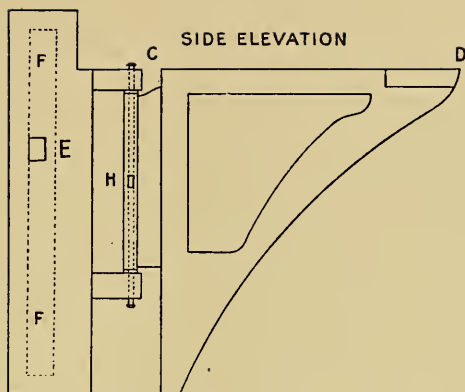


FIG. 47.

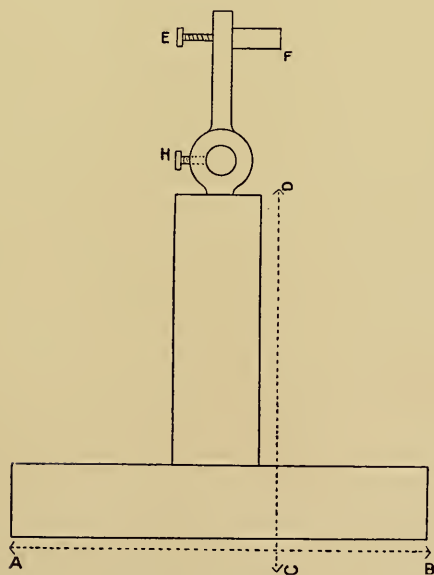


FIG. 48. PLAN.

as accurately shaped and squared as they should be. If fixed to their place without such defects being remedied, there is sure to be a binding of the parts at some point of the lift. In some cases this may be sufficient to cause something to smash—probably the bracket itself. The guage described is thought by some practical men to be somewhat heavy, and they use a much less guage with the spirit level on, which will only guage the spring piece one way. To get a correct setting the other way, a plumb-bob is used. Having finished with spring pieces we may attend to the

JACK SHAFT,

or main shaft of the frame. This comes to the mill generally with all the differential motion fitted upon it, but we strip it bare of everything at once. The bare shaft may then be passed into the frame, say from the outer end, if there be room. Often there is no room on account of the wall, in which case it is passed through the inside of the frame first. The all important point with regard to the jack shaft is to get it to work absolutely free and easy in its into bearings. The inner end is generally supported in a bearing that will allow of setting upwards or downwards, but not much sideways. The bracket at the outer end of the shaft will allow more for sideway movements of the shaft if such be necessary to get it to revolve sweetly. Of course the spirit level may be used on top of the shaft as on the top of the "coupling-up beam," etc., but it is more common and practicable to rely on turning the shaft by hand to see whether it works easily. If not, then one or both of the supports to the shaft are touched a bit in the required direction until an absolutely free and easy movement of the shaft is secured. Afterwards the shaft may be "dressed," or have the necessary wheels, etc., put upon it, and be finally made right. As becomes the importance of

this shaft, it is generally the strongest about the frame, being now made as much as $1\frac{3}{4}$ inch diameter. The "jack shaft" being done with we can next fix the

TOP CONE DRUM

and shaft. This cone shaft rests upon three bearings, viz., the gearing-frame end, and the first and second spring pieces. The proper places for these three bearings will probably have been marked at the machine shop, but some slight adjustments may be necessary. The cone drum is first pulled off the shaft, to which it is fastened by set screws. Then the shaft is put into its place, and made to work perfectly easy. The spirit level may be placed upon it to see whether it be level, but it is with this shaft, as with the jack shaft, more a question of tapping the bearings about a little, until the shaft is found to turn with a satisfactory amount of freedom. This desideratum being obtained, the cone is put upon the shaft again, and secured to its place, and the bearings made fast. Leaving the top cone we can turn to the

BOTTOM CONE SHAFT.

This is shorter than the top shaft, and only extends, say a little more than between the second and third spring pieces. We need not strip the cone off in order to set the shaft. On account of the thick end of this cone having to be lifted up, in order to slacken the cone belt when ready for doffing, it is sustained in a kind of swivel bearing at either end. The bearing at the thin end of the cone forms a fulcrum upon which the cone can be swivelled and yet work easily. On this account, perhaps, the bottom cone needs very little setting. The wheel on the end of the cone shaft is a change wheel, which can be changed to accommodate the winding and the lifter traverse to the

diameter of the empty bobbin, and consequently the bearings of the shaft may be put a little higher or lower, according to the diameter of this change wheel. The

BOTTOM RAIL,

or spindle rail, may now be put in its place. As we have said, the rail is divided into three portions, and some assistance will be needed to lift each of these portions to its place. There is usually a specially marked place on each spring piece, to receive the spindle rail, and the latter should need very little trouble as regards setting. It should need only a very short time to lift the different parts of the rail into their places, and connect them together and completely finish with it. It may want some little alteration afterwards in order to get some of the spindles to work easily.

Before putting top rail in, we must put in the lifter shaft. This, of course, extends the whole length of the frame, and may be in two or three parts, and it is now made upwards of $1\frac{3}{8}$ inch diameter. It will require to be made to work with freedom and ease, and the small lifter wheels will have to be put in their places along the shaft, but not to be screwed fast at present. The next thing to claim our attention is the lifter rail. It will need a great deal more fixing and setting than the bottom rail, The two rails have to be set to work together somewhat, as the spindles rest in the footsteps fixed in the bottom rail and pass upwards through their bolster bearings, fixed in the lifter rail. The spindle rail is a fixture, whilst the bobbin rail traverses up and down continually ; and this fact compels us to bestow considerable more attention upon the fixing and correct setting of the latter and its connections. As the rail is very heavy, particularly with long collars, and as it must be raised to some height, several men are needed to help at first, and these lay hold of number one piece of

lifter rail and raise it up. Pieces of wood of the proper dimension, say 7" or 8" broad and long, and about 1" thick, are placed upon the brackets or cross pieces of the bottom rails, and upon these the rail is rested and held steady by the men. Several spindles having been placed handy, two are dropped into their places at either end of the piece of rail; in each case, one spindle in the back row and one in the front row. These form a guide for the approximate position of the lifter rail. The slides or lifter racks at back of frame have hitherto been disconnected, but have been put ready each to its own place as they are generally marked or numbered. The fitter now goes to the back, and connects these to the lifter rail and spring pieces whilst the men steady the rail. A lifter weight and chain may now be hung at either end of this piece of rail, or hang the weights, say on the principle of the 1st, 3rd, 5th, etc. The wooden supports may now be taken from under the rail, and it will balance itself and be all right for the present. The same method of procedure may now be applied in getting the second and third pieces of rail to their places, the different pieces being connected together by a moderately strong plate. The important duty of setting the lifter rail must now be performed. First take two spindles, one for the back row and one for the front row in addition to the dozen or so spindles that have been already placed in position. Place these two spindles in position at every spring piece or oftener, and move the latter rail a little in or out, as the case may, be in order to get the spindles to revolve freely. There are slots for this purpose in the brackets upon which the lifter rail rests. We may now have all the spindles put into position and all the bobbin wheels and spindle wheels put in their places. It is vastly important that we should try all the spindles to see if they work easily enough. Easily-running spindles materially aid in getting a light-running frame. It may happen that by glancing along the tops of the spindles we can see that

they are in line and yet some spindles bind. In such cases the bottom rail may be moved slightly in the required direction or the collars re-adjusted. Again, we may have the spindles working easily, but they may not be in a absolutely straight line, as shown exaggerated below.



FIG. 49.

Chiefly to guard against this evil, we now set the spindles with a string, the two endmost spindles are raised up by having small pieces of wood placed under them in the footsteps. A string is extended from one of these spindles to the other, right over the apices of all the front line of spindles. If the front row be made right the back row will pretty well take care of itself. If the nick or aperture for the flyer in the top of each spindle be turned parallel with the string, the latter should be just over these nicks from one end of the frame to the other. The rails have to be adjusted until this desideratum is secured. This is exactly on the same principle as the string used in a mule for maintaining an equal distance from roller nip whilst at the same time the bevel in the spindles is made right. The lifter rail now requires to be set at the correct level or height all along its length. For this purpose a small guage of very simple construction is used. Fig. 50 shows

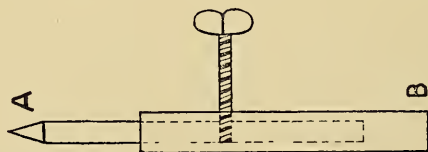


FIG. 50.

the idea. Sometimes, however, we may manage with a steel rule or a two-foot rule.

The bottom end **B** is rested on the small bobbin wheel, and the adjustable piece in the middle is raised until the apex **A** is exactly level with the spindle top, when it is screwed fast. Of course our lifter rail has to be first right at the starting point. At every spring piece the spindle points are made level with the guage. For instance, suppose at the second spring piece the point of the guage was below the point of the spindle to which it was applied, a pinch bar may be placed between the lifter rack and lifter wheel at this point, and the litter raised to the required degree, when the lifter wheel must be screwed firmly to the shaft. In some such manner get the lifter at the correct height for all its length. Before the final adjustments of the lifter are made, all the lifter weights should be put on. When we have entirely finished with the spindle and bobbin rails, the sooner we can get the the lifter and the spindle and bobbin wheels and shafts working and the better. For this purpose we may now fix all the

NECESSARY GEARING,

including the wheels at the end of the frame for driving the spindles, the swing wheels, the fly wheel, and fast and loose pulleys, etc. The spindle footsteps and bolsters, and all the proper bearing surfaces, must be exceedingly well oiled, or, in some cases, tallowed, to prevent wearing and heating, which are always more liable to occur at first than afterwards. Those things being done, the driving belt may be put on, and the above-mentioned things allowed to work several hours. Their operation must be carefully watched, and such various little adjustments made as this testing may reveal the necessity for. While the above parts are running we may be putting the

CREEL

up. Chiefly on account of the heavier bobbins and the greater frequency of creeling, and the thicker nature of the cotton as compared with the mule, these creels are made of angle iron, instead of having the wooden creels and pot steps used on the latter machine. Each portion of the creel is numbered or lettered to its own place, and when such portion is properly allocated to that place, no great skill or knowledge is required in putting the creel up. The rollers may next receive attention. As they are new from the shop it is not likely that much adjustment will be necessary in connection with them. The iron rollers are fitted to one another, the chief point being to take care that each roller is put in its own place, according to number or letter upon it. If they do not revolve easily in the stands, it is possible some little adjustment of the latter will be necessary. The square section, "spigots," or ends should be well rubbed with oil before being fitted into their respective sockets. The iron and leather rollers being all put in, the labourer may put on the "saddles" and "hangers," and attach the weights to the latter, or this operation may possibly be deferred a little. It is perhaps advisable at this juncture to attend to all those portions of gearing, etc., that have not yet been fixed, such, for instance, as the various change wheels, guards, covers, etc. As important a duty as any is to set the "hanger bar" or "diminishing rod" level in the centre of the lift, and the adjustable screws for the "escape motion" to release the latter, with the lifts at the proper distances from the extremities of the bobbins. The exact methods of performing these operations is detailed elsewhere in this treatise. The frame, having had the creel bobbins put in, and other small duties attended to, may now be considered ready for launching on its round of duties. At first, however, it may be deemed advisable to

make bobbins only upon a few spindles, in order to get the shape of bobbin and the twist, etc., exactly to our liking. The size of ratchet wheel, change pinion for draft, lifter wheel and twist wheel, require carefully working out by rules elsewhere given in this treatise.

REPAIRING OF BOBBIN OF FLY FRAMES.

There is much less labour and expense involved in the repairing of a fly frame than in the case of a self-acting mule, but yet a good deal more than in the case of the draw frame, as described previously.

FLYERS.

These are an exceedingly important item in the economy of the series of machines under notice. Imperfections in their construction and balancing tell heavily against the steady working of the frame. Their weight, and somewhat curious construction and comparatively high rate of revolution, combine in making their perfect balancing a matter of primary importance. They may be perfectly balanced when the frame is first started, but many circumstances operate to their detriment. For instance, it is the common practice with frame tenters to place on the lifter rail at some time during the progress of a set of bobbins, the empty bobbins which will be required to place on the spindles when the frame is doffed. When doffing takes place, it sometimes happens that all these empty bobbins are not used up, and are by mistake left on the rail. When the frame is started again the rail will have its maximum lift, and the bottom of the flyer legs come against the empty bobbins with detrimental results. This is, perhaps, worse in slubbers, because of the thickness of the empty bobbins. Again, the bobbins when doffed

are sometimes a portion of them placed on the flats. When these are taken off again with the frame running, the tenter may allow one to fall in between the roller beam and the back row of flyers, or between the front and back rows of flyers. In either case the result often is that one or more flyers are strained. These are only just two out of many ways in which the flyers can be damaged. When they are damaged both the steadiness of the frame and the build of the bobbin are affected for the worse. To demonstrate this assertion, let it be assumed that the centre of the hole in the flyer top is exactly in the same vertical plane as the point in the presser finger through which the roving passes on to the bobbin. This is done in order to obtain the maximum benefit out of the presser finger. The correct distance from the centre of the bobbin to the flyer leg containing the presser we will assume to be $2\frac{1}{2}$ inches. The leg gets strained outwards until this $2\frac{1}{2}$ inches is made into 3 inches. In this case the roving will have further to go in its passage to the bobbin, and both the roving and the build of the bobbin will be detrimentally affected, and the action of the presser finger will be somewhat defective. The bobbin will be a little softer. Moreover, it will conduce to an unsteady running of the spindle.

The author is convinced that in many cases an accurate balancing of the flyers would be of the utmost benefit to frames that are running.

This work of balancing the flyers is, however, often done indifferently, and a good carder will see that no undue hurry causes the work to be badly done. For certain diameters of bobbins, the presser fingers should all be of one certain curve, as this point affects the winding of the bobbin. The flyers are, in the first instance, very well finished and highly polished, and generally made of a very close-grained material. This is to prevent the rapid accumulation of fly into small "slubs," which may pass forward upon the bobbin. From various causes the

flyers are apt to become more or less dirty, and in repairing the frame they should be well cleaned. On this point the author had to do with a case in which the mill had been stopped for a long time. The flyers had become thoroughly impregnated with rust. They were very well cleaned at the mill before starting, and this was esteemed to be enough. Afterwards, however, there was an endless amount of trouble caused by the roving being full of slubs. It clearly originated with the flyers, and it became apparent that they ought to have been sent to a machine works and been thoroughly cleaned up and balanced. This was done with highly beneficial results.

LIFTER SLIDES.

Owing to the tempering of the steel spindles leaving them a little softer in some portions than others, and to the flyers being out of balance, more or less, and to the pull of the roving, and other causes, it often happens that spindles wear on one side to about the extent of the lift in their length. This peculiarity the author has often noticed. It causes vibration of the lifter by the full and shallow sides of the spindle alternately pressing against the collar. The lifter vibration shakes the sides against the sides of the spring piece lifter guides, resulting in a wearing of the latter. These may be taken out and reduced in size sufficiently to make them uniform, and to allow of a piece of iron being riveted or pinned on to the sides of the slide, in order to compensate for the wear. The worn spindles may be fitted with phosphor bronze collars.

SPINDLE TOPS.

The slits on the tops of the spindles may become worn, or the pegs or pins in the flyers which fit into the spindle slots may become worn. Backlash in starting the frame has a

strong tendency to produce above wear, and when once a small amount of wear has set in it will rapidly make itself worse. The flyers should be re-pegged, and the slits in the spindle tops repaired, so that a good fit between the two is ensured by uneven drawing.

LIFTER SHAFTS.

In the course of time these will wear somewhat in their bearing surfaces. The result is a faulty operation of the small lifter wheels in connection with the lifter slides. To overcome this, the lifter shaft may be turned round completely, which will bring fresh and unworn places to work in the bearings. Or a piece may be put on one end of the shaft to throw the worn portions out of the bearings.

SKEW GEAR SHAFTS.

The same remark applies to the spindle and bobbin shafts. They also, to compensate for wear in the bearings, may be turned round, in order to bring unworn portions to work in the bearings. This remark more particularly applies to the ends of these shafts, which have their bearings in the frame ends. As these carry the driving wheels they are more liable to wear than the other bearing points, and also for the same reason wear at these places is more detrimental than at other parts of their length. In some cases, instead of turning these shafts round, the ends are cut off, and new ends are pieced to the shafts. In many new frames now made these shaft ends are made in specially short lengths, which are coupled up to the other parts of the shaft. This gives much greater facility for renewal, and also the short lengths may be hardened to prevent wear.

CONE SHAFTS.

The cones have occasionally a tendency to wear slack on the shafts. All such irregularities should be obviated if

the cone belt is to do its work with a maximum amount of efficiency. The two cone shafts should each be set level with the spirit level, and one should be re-set in an exact parallel line to the other. Also a plumb line may be dropped from the edge of the top cone, and by this means the edges of the bottom cone may be set in exactly the same vertical line as the edges of the top cone, which is an essential thing if accurate winding is to be maintained. Wear in the bearings of any of the shafts should be obviated. In particular, any such wear in the reversing motion should be attended to.

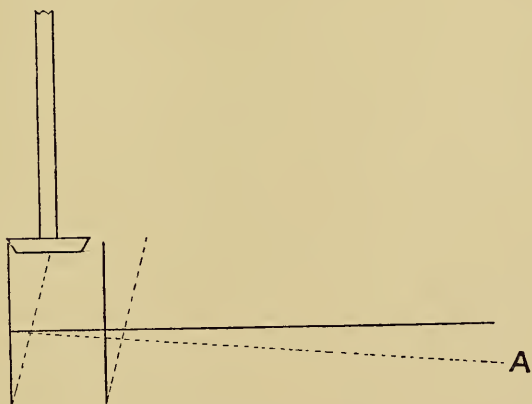


FIG. 51.

To show the importance of this remark, let the straight lines in Fig. 51 represent the reversing motion bevels and shaft. If the shaft was down, as at **A**, either from wear in the bearings or any other cause, it would cause the shaft and bevels to assume the positions indicated by the dotted lines. It is quite clear that this would result in extremely faulty gearing of the bevels with the small strike wheel. All worn spindle and bobbin wheels should be renewed.

The spindle footsteps will often be worn, and should therefore be renewed. So also should any defective bobbin collars. Other wheels, such as the lifter drawing wheels and cone end wheels may be defective, or their studs may be worn, and in a thorough repairing of the frames all such worn parts should be renewed. The spindle and bobbin rails and roller beams should be lined after the manner described in the erection of a bobbin and fly frame. Particular attention should be directed to the obviation of defects which will tend to cause running under and over of the bobbins. These parts are chiefly enumerated in the article in this treatise on running under and over. The rollers and roller stands will need attention if we are having frames systematically and thoroughly repaired.

The flutes of the rollers themselves are apt to get damaged and worn in various ways, with the result that their drawing power is lessened. If knocked places are pressed in them, the roving will adhere thereto, and break and lap round the rollers. Also, occasionally the squares or the necks become worn. The iron rollers should therefore be repaired. The brass-bearing surfaces of the stands are liable to get worn, and particularly if cleaning and oiling have been neglected. Fresh brasses should be put in, and filed down to a template, in order to have the rollers bearing equally on all the stands. This latter point is of high importance, and, besides the stands being bushed alike, considerable care is necessary in fitting the stands accurately to their places. They should be lined up during the repairs. A string may be extended along the front line of rollers, and pieces of brown paper put under the string at the frame ends. By the use of the string we can tell whether the brass-bearing surfaces of the stands are all of the same height, so that they shall bear an equal share in supporting the rollers. Also, we can tell whether the stands are linable with each other. The iron rollers will also require re-adjusting, according to the staple of cotton.

The frame overlooker should himself attend to this point. The leather rollers should be recovered where necessary, and carefully re-set. All saddles and saddle wires and hangers should be attended to. A point which few carders seem to regard with a sufficient amount of importance, is as follows:—A small straight-edge or one side of a small square should be held perpendicularly against the face of the iron rollers, and the front leather rollers brought forward to touch this square; so that they will rest properly upon the iron rollers when the frame is running. The front leather rollers should be treated so as to have them all alike. What is the same thing, but much handier, a string may be extended along the front top edge of the iron rollers in an exactly parallel line to the rollers, and then each cap neb brought forward to have its front edge touching this string. The attention of practical carders is strongly directed to this mode of setting the cap nebs. By this means the leather rollers are kept rigid just in front of the top centre of the iron rollers, as the direction of revolution of the rollers, and this mode of setting, combine in keeping the rollers in that position. With other styles of setting the author has often seen the top rollers fall back when the frame was stopped, and then when it was started again the rollers would move forward and thin places be caused in the roving. There are many firms of greater or less importance who are ready to undertake repairs to fly frames. The price generally charged per fitter for doing work not contracted for is 10d. per hour. This is for ordinary engine time. Overtime, fares, and allowances are charged for as extras. The repairs will generally be undertaken at something like the following rates, a little more or less, as the case might be. Re-fluting the rollers from 7d. to 10d. each; roller stands bushed and re-cut 6d. or 7d. per journal; new and square ends to the rollers 1s. 6d. each; turning the lifter shaft round 1s. 6d. per frame; changing bearings on spindle and bobbin

wheel shafts 1s. per frame; new collars 7d. each; footsteps to the spindle wheels 4d. each; bobbin wheels 7d. each; spindle wheels 6d. each; shaft wheels 6d. each; split shaft wheels 1s. 6d. each or less; re-bushing spindle wheel shaft bearings 4d. each. With respect to the flyers, entirely new flyers may be from 2s. to 3s.; new roving pressers 6d. each; new slubber or intermediate pressers 9d. each; skimming flyer tops 6d. per dozen; new brass lumps 3d. each. The old brass lumps may be re-soldered at 2d. each. Buffing all over 6d. per dozen, Mopping, scouring and cleaning out the throats about 3d. per dozen. These prices are only approximate, and are always subject to various modifications. They are prices which, at one time or another, were submitted to the writer in actual practice.

BRONZE COLLARS, OR SUMNER'S PATENT SYSTEM.

It has been previously stated that the spindles by long running became worn at that portion which was traversed by the collar of the top rail. Also that this wear was often one-sided. The non-wearable qualities of Phosphor-Bronze have been largely utilised to remedy this. The method of procedure is as follows:—The worn portion of each spindle is ground down to be as cylindrical as possible. Upon this thinner portion of the spindle is now sprung a phosphor-bronze collar, to fit neatly into the thin portion and to bring it up to the same thickness as the rest part of the spindle. The collars are, of course, of various thicknesses, in order to allow of greater or less wear of the spindle. The application of these collars has proved very effective in many cases where it has been skilfully carried out. Many carders and masters prefer, however, when the spindles are badly worn, to buy new spindles altogether,

However excellently well the collars are applied, it can scarcely be alleged that they are quite as good as new in every respect. The difference between the price of a new spindle and having the old one thoroughly repaired is not so great. Best steel spindles can be got from Sheffield at about 3s. 6d. each, and it is quite possible to get them for less. As will be seen a few pages later on, to effectively repair slubbing spindles costs about two shillings each, over all. The temper of the steel spindles is not improved by grinding. There is at times a tendency for the collars to ride upon the thicker portions of the spindles if they get too slack. Wherever this system has been applied to the spindles a number of bronze collars should be kept on hand.

It may be remarked here that the best thing of all is to keep the frames well oiled and cleaned, and the parts accurately adjusted, and then there will be little need of repairing.

The author is conversant with many frames which have been running 25 years or more in which the spindles and skew spindle bevels, &c., are practically as good as new. Next to nothing has been spent upon them for repairs. The spindle bevels, as a rule, receive plenty of oil that runs off other parts. The parts were composed of good raw material at the first, and were well put up, and the frames have been well looked after. They are running at the time of writing, are giving little trouble, and turning off a good proportion of hanks per spindle.

The alteration to bronze collars, or Sumner's patent system, has been largely undertaken, and firms are willing to contract for it at something like the following rates:—Slubbing frames, $\frac{3}{4}$ in. or $1\frac{3}{8}$ in. spindle, at 1s. 11d. or 2s. per spindle; intermediate frames, $\frac{3}{4}$ in. spindle, at about 1s. 10d. per spindle; roving frames, $\frac{1}{2}$ in., $\frac{5}{8}$ in., or $1\frac{1}{8}$ in. spindle, at about 1s. 5d. to 1s. 7d. per spindle. In case spindles are too far worn to grind up, new ones will have

to be substituted, and this costs from 6d. for the thin spindles, to about 10d. for the thick spindles extra to the charges for putting bronze collars on. The scrap may be allowed for at from 3s. to 4s. per cwt., or returned to the spinner. The above prices include alteration to spindles, collars, footsteps, re-pegging, rancing out and balancing the flyers, lining-up the roller beam and spindle rails. Within a few miles, say six or seven, the repairing firms will often undertake cost of carrying material between the spinning mill and the repairing works. Beyond this distance the spinner must pay carriage one way and the repairing firm the other. The spinner must strip the frames and forward the material to the repairing works, clean the frame ready for the fitter, and provide the fitter with a labourer during the re-fixing of the material.

CHAPTER VIII.

NEW HIGH SPEED DIFFERENTIAL MOTION.

MESSRS. BROOKS & DOXEY'S NEW PATENT DIFFERENTIAL MOTION.

Some years ago, Mr. G. Shaw, chief draughtsman for the above firm, invented an ingenious winding motion, which was patented by his firm and applied to their new bobbin and fly frames. After extended application, however, they have recently substituted for it the motion now to be described. Their former motion performed the work imposed upon it with little strain upon the cone belt. It was found, however, that, when subjected to the high speeds of modern roving frames, some wearing of the parts took place, owing to the fact that it contained a high speed worm, and a small worm wheel upon which all the weight of the bobbin devolved.

The new motion is by the same inventor, who has probably devoted as much time to the special subject of differential motions for bobbin and fly frames as any man living. It certainly appears to be free from the defects of the former motion, and the author of this book, who has given considerable time to a study of its special features, gives it as his opinion that it is now a very satisfactory winding motion.

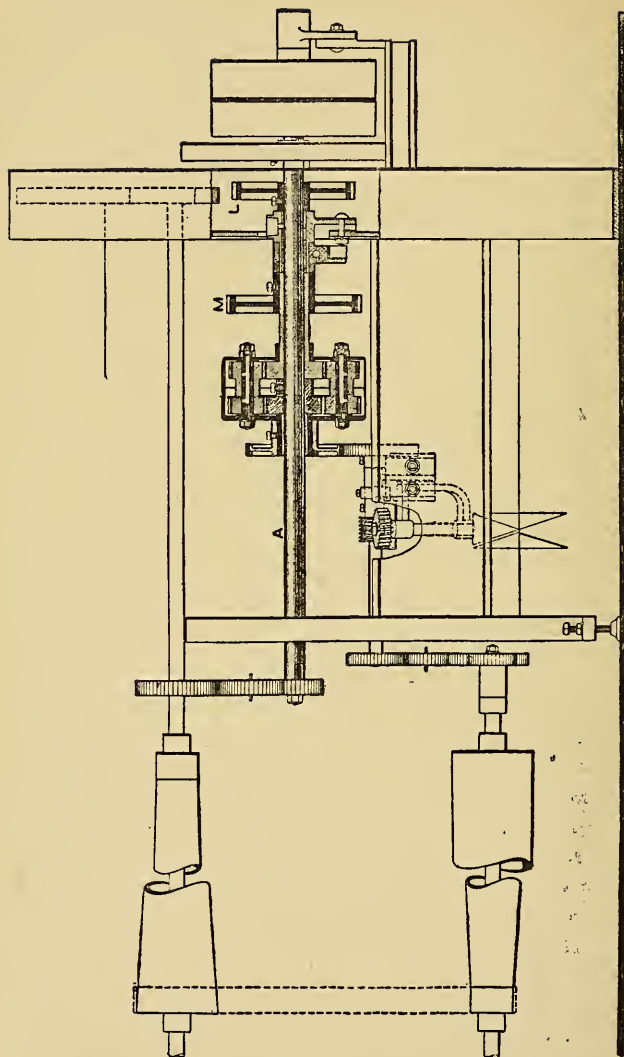


FIG. 52

DETAILS OF CONSTRUCTION.

To illustrate the construction and mode of operation of of this motion reference must be made to Figs. 52, 53 and 54. In all these figures **A** is the first motion shaft of the machine. Referring, in the first instance, to Fig. 52, a general view of the new motion and all its connections is shown. Only three portions of mechanism are lettered here, viz., **A**, the main shaft, **L**, the wheel for driving the spindles; and **M**, which is the bobbin-driving wheel, or the wheel which may be regarded as the first belonging to the "swing." The chief point which must be noticed in this fig. is the fact that **M**, for driving the bobbins, is larger than **L**, for driving the spindles. This is one of the chief features of nearly all the new motions, as it does not appear to exist in any frames with Holdsworth's motion. In the latter motion these wheels, **L** and **M**, are invariably made of the same size, so that when both revolve at the same speed the bobbins and spindles likewise have the same speed as each other. At one end of the main shaft **A** in Fig. 52, is shown the twist wheel, for driving the top cone drum, and at the other end are the fast and loose pulleys and the fly wheel. The bottom cone drum controls the motive power for the variable portion of the differential motion, the connections between the two being shown on the left of Fig. 52. Figs. 53 and 54 are enlarged views strictly confined to the new mechanism only of the winding motion. Fixed to the shaft **A** is a spur wheel **B**. Upon the left side of the wheel **B** is the loose sleeve **C**, which is in one piece with the disc **C**¹, and is firmly secured to the wheel, which is controlled by the bottom cone drum, as shown in Fig. 52. Upon the other or right side is another loose sleeve, **D**, which is in one piece with the wheel **D**¹. Also on the other end of the sleeve is secured the wheel **M**, for driving the bobbins. Upon the loose sleeve **D** runs loosely the disc **G**, which, with the disc **C**¹ forms a complete casing for the mechanism.

Brooks & Doxey's

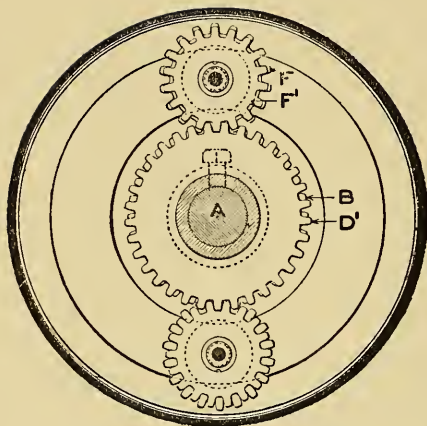


FIG. 53.

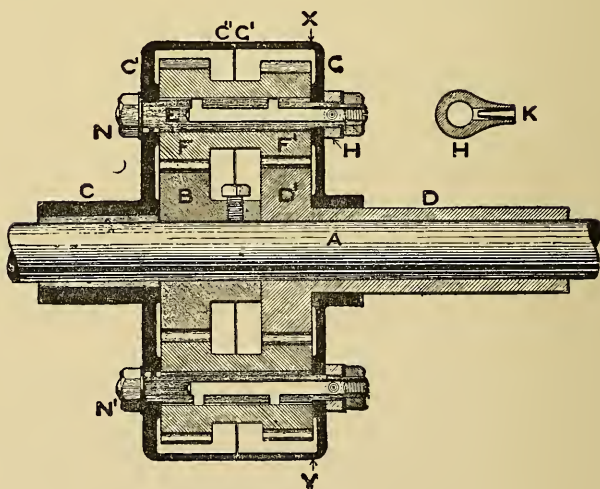


FIG. 54.

It must be distinctly understood that the wheel **D**¹ is not connected either to the shaft or to the disc **C**¹ or **G**.

There are two wheels which are inside the disc or box, and are upon the main shaft **A**. **B** is fast to the shaft, and contains 30 teeth. **D**¹ is loose on the shaft, and usually contains 33 teeth for a roving frame. Fixed to the disc **C**¹ by nuts **N** and **N**¹ are two studs **E**. Upon these studs are double-carrier pinions **F** and **F**¹, each containing 18 teeth.

It must be specially noted at this point that two studs and two double carriers are not indispensable to the working of the motion. Exactly as in Holdsworth's motion, one of the double carriers is introduced simply as a balance wheel. It will assist the reader therefore in comprehending the motion if he at first leaves the stud and its double carrier, as shown at the lower part of Fig. 54, out of consideration altogether.

Of course, as the two halves **F** and **F**¹ of the double carrier on stud **E** are cast together, they are compelled to revolve together. The two studs are set parallel to the main shaft, and the double carriers extend along the faces of the two wheels **B** and **D**¹ on the shaft. **F** gears with the fast 30-wheel **B**, and **F**¹ gears with the loose 33-wheel **D**¹. In addition to holding the double carriers, the studs **E** secure the two discs **C**¹ and **G** together, and these, meeting at the flanges, **C**¹ and **G**¹ form an oil-tight joint. The arrangement of the parts is ingeniously contrived for the discs to form an exceedingly neat cover, whilst at the same time they are indispensable to the working of the motion. The two discs, **C**¹ and **G**, which for all practical purposes may be considered as one piece—the two wheels **B** and **D**¹, and the two studs **E**, with the double carriers revolving on them, may be considered as all the special parts of the motion.

ACTION OF THE PARTS.

We may now examine the action of the parts, and this we will do for the commencement of a set of bobbins, for the middle of the bobbins, for full bobbins, and when running ends slack for doffing purposes.

WHEN STARTING A SET OF BOBBINS.

At this point the fast wheel **B**, the double-carrier pinions **F** and **F**¹, and the loose wheel **D**¹, all act together as clutch wheels, after the style of the two halves of the roller box on a self-acting mule. As the fast wheel **B** revolves with the shaft it attempts to take the wheels **F** and **F**¹. We have thus two elements acting at the same time, with the object of making the double carriers move round at the same speed as the fast wheel **B**. These are, 1st—the wheels acting as clutch wheels, and **B** thus attempting to take the other wheels round. 2nd—the efforts of **B** being supplemented and aided by the cone drums.

The result is that there is little strain on the cone belt, and the wheels all revolve together exactly as if they were clutch wheels, and just as if they were pinned together. At this time the double carriers **F** and **F**¹ are stationary, or almost so, on their own axis, having only the motion of the discs to which their studs are attached. The loose wheel **D**¹ being thus made to revolve at the same speed as shaft **A**, and in the same direction, we can now connect its revolution to the bobbins. Reverting again to Fig. 52 we see that **M**, which is the bobbin driver, is practically one with **D**¹, and must revolve at the same speed. The wheel **L**, for driving the spindles, being fast to the shaft, will also revolve at the same speed as wheel **B**.

In Holdsworth's motion these two wheels **M** and **L** are of the same size. In Shaw's motion for a roving frame **M** has 66 teeth, and **L** 60 teeth. The other wheels for driving the spindles are the same size as the wheels for driving

the bobbins. Clearly, therefore, the bobbins being driven from a 66 wheel will revolve more quickly than the spindles which are driven from a 60 wheel. The increase of speed thus given to the bobbins is sufficient to take up the roving as it is delivered from the rollers, or, in other words, to accomplish the winding for the empty bobbin.

MIDDLE OF BOBBIN.

Immediately the cone belt begins to move up the bottom cone, the discs, and consequently the double carriers **F** and **F¹**, are compelled to move at a slower rate round than the main shaft **A** and the fast wheel **B**. This slightly disturbs the clutch-wheel action of the wheels, and compels the double carriers to revolve on their own axis to a very limited extent. This is where the action of an epicyclic train of wheels commences, and, clearly, the revolution of the carriers on their own axes will either speed up or slower down the revolutions of the loose wheel **D¹**, according to the relative sizes of wheels **B** and **D¹**. The real action is that the latter is made to revolve more slowly. The slower the revolution of the bottom cone, and consequently of the discs and the more are the double carriers revolved on their own axes, also the more are the bobbins retarded in their speed.

WHEN BOBBINS ARE FULL.

At this point the lower cone and the discs are revolving at their slowest speed, and consequently the double carriers are compelled to revolve somewhat quickly on their own axes, and therefore at this point they exercise their greatest retarding effect on the loose wheel **D¹** and the bobbins.

RUNNING ENDS SLACK FOR DOFFING.

At this point an absolutely new set of conditions are set up, differing from those which obtain during the time the

bobbins are being made. In this respect Brooks & Doxey's motion differs perhaps from all others. All the time the bobbins are being made the wheels inside the motion are all acting as clutch wheels. At the commencement of a set of bobbins there is practically no motion in the wheels other than what results from the clutch-wheel action. When the double carriers begin to revolve on their own axes, the clutch-wheel action still continues, but the clutch point is being revolved round wheel **B**. When, however, in readiness for doffing, the bottom cone is lifted up, the discs practically cease to revolve, and the bobbins are then driven in a different manner. The double carriers, the fast wheel **B**, and the loose wheel **D**¹ are all at once practically resolved into an ordinary train of wheels, and the ordinary rule for speeds can now be applied in order to find the revolutions per minute of the bobbins. As previously stated, in order to get the maximum speed of the bobbins when starting a fresh set, with absolutely no motion of the double carriers on their own axes, the bobbin wheel **M** has 66 teeth, whereas the spindle wheel **L** has only 60 teeth; and in order to produce *accurate building of the bobbin*, it is necessary that wheel **B** has 30 teeth and wheel **D**¹ 33 teeth. To prove, now, that the spindles and bobbins will revolve at the same speed as each other when doffing, we will work two simple speed calculations. Assume that we have the following particulars:—Speed of jack, or main shaft, 400 per minute; bevels on bobbin and spindle shafts, 50 teeth; small bobbin and small spindle bevels, 25 teeth; spur wheels on end of spindle and bobbin shafts, 40 teeth. Other sizes as given above.

Speed of spindles equals—

$$\frac{400 \times 60 \times 50}{40 \times 25} = 1200$$

Speed of bobbins equal—

$$\frac{400 \times 30 \times 66 \times 50}{33 \times 40 \times 25} = 1200$$

A few general remarks may now be made respecting the motion. It may be pointed out that it has several very good features. In common with all the other new motions, all its parts revolve in the same direction as the main shaft. The stud **E** is bored as shown, in order that the double-carrier pinions **F** and **F**¹ may be oiled from outside the casing. Also the out ends of this stud are provided with oil cups **H** and nozzles **K**, which effectually prevent any oil being thrown off outside the casing. This effective oiling, added to the fact that the double carriers have such a slow motion on their own axis, gives a small amount of wear and tear of the parts. It is somewhat in favour of the motion also that nothing but spur wheels are used. The parts are simple and very accessible.

RE-ACTION OF BOBBINS.

The most distinctive feature, however, is the fact that the re-action from the bobbins passes directly upon the frame shaft, whereas in Holdsworth's motion this re-action passes upon the cone belt, and puts a great load on the belt. The author has tested Holdsworth's motion, both on frames and with models, and can testify to this re-action of the bobbins loading the cone belt. He has also tested Shaw's motion with the aid of specially constructed models, and he is perfectly convinced that in this motion the re-action goes on the frame shaft and not on the belt. Some of the new motions are by no means free from this re-action, which, in the author's opinion, is one of the worse defects in Holdsworth's motion.

It has been remarked before that the wheel **M** was made with 66 teeth for a roving frame, and the spindle wheel **L** with 60 teeth. The wheel **M** is not the same size for slubbing frames as for roving frames. In a slubbing frame much more yarn is delivered to one revolution of the

spindle than in a roving frame, consequently, the empty bobbin must run quicker in proportion. In order to keep the differential motion, *i.e.*, the double carriers and the loose wheel **D**¹, running at the same speed as the shaft at the commencement of a set of bobbins, it becomes necessary to increase the size of the wheel **M** in proportion to the increased delivery. For a slubbing frame this wheel would have 74 teeth; for an intermediate 70 teeth; and for a roving 66 teeth; whilst the spindle-driving wheel **L** remains constant at 60. Now a little reflection will convince anyone that if the wheel **M** be increased, so also must the wheel **D**¹ in the same proportion. As a matter of fact the wheel **D**¹ is not fixed in size until after **M** is determined, and is directly proportional thereto. Its three sizes are:—slubbing 37, intermediate 35, roving 33. It will be noticed that it is always just half the size of **M**.

FOR FLYER LEADING.

In frames which have the flyer to lead, the bobbins must run at commencement considerably slower than the spindles, and gradually be speeded up as the bobbins increase in size. This, of course, is exactly opposite to what is obtained in bobbin leading. To produce the requisite effects for flyer leading with the above motion, the wheel **M** which drives the bobbins would be made just as much less than the spindle wheel **L** as for bobbin leading it is made larger. This would give the correct winding whilst the bobbins were being made. In order to produce correct winding, the size of the wheels **B** and **D**¹ would have to be reversed. For a roving frame **B** would have 33 teeth, or about that, and **D**¹ 30 teeth. **D**¹ would remain constant, and **B** would increase in proportion as **M** decreased.

The following remarks tend to explain as to what conditions govern the sizes of the wheels **B** and **D**¹. These

wheels are entirely governed by the following. Take a roving frame for example:—Driving shaft running 372; spindles, 1,100; bobbin, $1\frac{1}{2}''$ to $3\frac{3}{4}''$ diameter; hank, say, $3\frac{1}{2}$. Based on this the revs. gain of an $1\frac{1}{2}''$ tube would be about 42. Therefore the initial speed = $1100 + 103 = 1203$, and the finishing speed = $1100 + 42 = 1142$. Thus, the bobbin varies from 1203 to 1142, and the wheel D^1 must be governed so that its speed varies in proportion to this. Now, the speed of the lifting rail varies in inverse proportion to the diameter of the bobbin, and this *must be infallibly carried out* or else the layers per inch would vary, and the bobbin would increase in diameter at a variable rate. Consequently, the speed of the disc C^1 requires to vary inversely in proportion to the diameter of bobbin, or as $3\frac{3}{4}'' : 1\frac{1}{2}''$, thus, $3\frac{3}{4}'' : 1\frac{1}{2}'' :: 372 : x = 148.8$. Therefore, wheel D^1 varies from 1203 to $1142 = 5\%$, and disc C^1 varies from 372 to $148.8 = 60\%$. It could be proved mathematically that this result could not be accurately obtained except by employing in the motion the ranges of gearing given.

MESSRS. HOWARD & BULLOUGH'S MOTION.

The motion adopted by the above firm is the invention of Mr. Tweedale. It has certain distinctive features of its own, whilst at the same time partaking of the principles of Holdsworth's motion, and some of the features of all the new motions. To merely glance at it one would think that it was a very simple motion, as indeed it is, in so far as its parts are concerned. At the same time the action of the parts is somewhat complicated, and to thoroughly comprehend this action at all parts of a set of bobbins will require a fair amount of study.

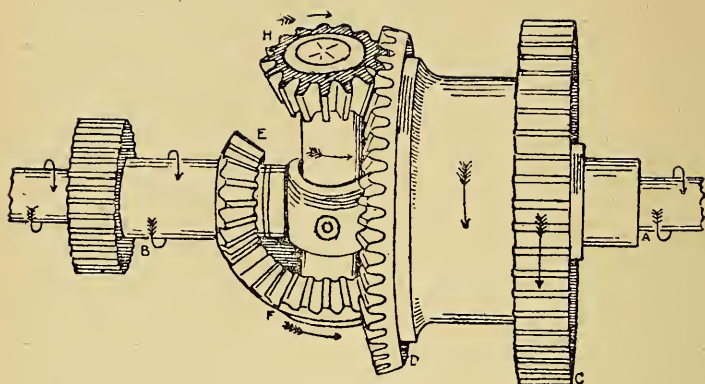


FIG. 55.

DESCRIPTION OF PARTS.

Referring to Fig. 55, the shaft **A** running through the whole of the mechanism is the jack shaft or main shaft of the frame. In the centre of the parts shown it will be seen that on the main shaft is cast a boss, or cross piece **G**. Through this boss is passed a short transverse or cross shaft, upon one end of which is the wheel **F**, and upon the other end is the smaller wheel **H**, both wheels being secured firmly to the cross shaft. This shaft is capable of being revolved on its own axis, and at the same time it is carried bodily round with the main shaft. The two wheels on its extremities have thus a general compound motion, exactly of the same character as the two carriers in the arms of the sun wheel in Holdsworth's motion. In actual work, to trace the exact amount of axial and bodily motion which these wheels have at all parts of the set, and the effect thereby produced upon the revolution of the bobbins, constitutes the chief difficulty of understanding the motion. The other parts of the motion are the compound wheel **B E**, and the much larger compound bell

wheel **C D** on the opposite side of the short cross shaft. The wheel **B** is driven from the lower cone drum, and **C** is the bobbin-driving wheel. Briefly, then, the parts of this motion consist of four bevel wheels and two spur wheels, and these six wheels work in three pairs. The direction of motion of these three pairs of wheels and of the shaft **A** is indicated by the arrows.

ACTION OF PARTS WHEN SLACKENING ENDS FOR DOFFING.

It will be shown presently that there are three elements of action in this motion, and as only two of the elements are at work when running ends slack for doffing, it is deemed best to first explain the action of the parts at that time. At the outset it will be as well if actual working sizes of the different wheels are given. These are as follows:—

Wheel on Main Shaft for driving Spindles	...	40 teeth.
" " " " Bobbins	...	50 "
Wheels on end of Bobbin and Spindle Shafts	...	37 "
Bevels on " " " "	...	55 "
Small Bobbin and Spindle Bevels	...	22 "
Small Bevel E , compounded with B	...	18 "
Driving large Bevel F on Cross Shaft	...	30 "
Small Bevel H on Cross Shaft	...	16 "
Driving large Bevel D , compounded with C	...	48 "

The speed of the Main Shaft may be taken at 400 per min.

When running ends slack for doffing the wheels **B** and **E** are absolutely stationary, as they are driven from the lower cone drum, and the latter is stopped by the belt being slackened in the usual way. The main shaft **A** being revolved, it of course carries the short transverse shaft and the bevels **F H** bodily along with it. The small bevel **H** being in gear with the large bevel **D**, the latter is thus carried round with the cross shaft. The two wheels **H D** act as the two halves of a clutch box. The action now

would be quite easy to comprehend were it not that the bevel **F** on the other end of the cross shaft is in gear with the bevel **E**, which latter is at this point stationary. If it were not for this connection the bell wheel **C-D** would revolve at just the same speed as the main shaft, and the cross shaft would have absolutely no motion on its own axis. This connection of **F** and **E**, however, compels the cross shaft to have an axial movement, in addition to a bodily movement. Just according to the extent of the axial movement of the cross shaft the compound bell wheel **C-D** is made to revolve slower. This can be shown best by calculations based on the above figures. Supposing the short cross shaft to have no movement on its own axis, the speed of the bell wheel **C-D** would be the same as the main shaft, viz.: 400 per minute, and the speed of the bobbins would be :—

$$\frac{400 \times 50 \times 55}{37 \times 22} = (a.) = 1351.35.$$

As a matter of fact, however, the cross shaft has an axial movement, due to the main shaft revolving wheel **F** at 400 per minute round **E**. This reduces the speed of the bobbins to an extent shown by the following speed calculations, the sizes of wheels being as given in above tables :—

$$\frac{400 \times 18 \times 16 \times 50 \times 55}{30 \times 48 \times 37 \times 22} = (b.) = 270.27.$$

The true speed of the bobbins then equals **a—b**, or

$$1351.35 - 270.27, \text{ or } \frac{400 \times 50 \times 55}{37 \times 22} - \frac{400 \times 18 \times 16 \times 50 \times 55}{30 \times 48 \times 37 \times 22} = 1081.1 \text{ revols. per minutes of bobbins.}$$

This should, at this point, be equal to the speed of the spindles, and the latter can be easily found from the particulars given in above table, thus :—

$$\frac{400 \times 40 \times 55}{37 \times 22} = 1081.1 \text{ revols. per min. of spindles.}$$

When running ends slack for doffing purposes, clearly the two speeds are equal, which is the necessary condition

at this time. In order to convey a clearer perception of the exact action of the cross shaft and wheels **F H** upon it at this point, reference may be made to an ordinary wrap reel. By turning the handle of such a reel once round, it is seen that two revolutions are given to the reel. This is due to the wheel that is carried round having two motions—it revolves on its own axis, and it is carried bodily round. Both motions tend simultaneously to revolve the reel. First, by a clutch wheel action; second, by the carrier wheel revolving on its own axis. Now, in Tweedale's differential motion, there is a different effect produced to the above. The clutch wheel action is exactly the same. There are, however, two wheels carried round instead of one, and the result is, that the axial movement is in the contrary direction to what takes place on a wrap reel. Clearly, therefore, if in a reel the axial movement of carrier wheel causes reel to revolve, then, in Tweedale's motion, where the axial movement is in the opposite direction, the effect will be to reduce speed of bell wheel **C-D** (which is identical with the reel), and not to accelerate it.

WHEN STARTING A NEW SET OF BOBBINS.

It has been shown that when running the ends slack for doffing, and the wheels **B, E** were stationary, there were two elements of action which affected the bobbins. A little reflection will show that if the wheel **E**, which drives the cross shaft, be revolved, a third element of action will be introduced. The cross shaft already has a motion on its own axis, caused by its being carried round with the main shaft. If, therefore, wheel **E** be revolved, it will be an additional factor to the motion of the cross shaft. It depends upon which way the wheel **E** is revolved whether it will cause the cross shaft to go more quickly in the direction it is already moving in, or whether it will hinder the revolution of the cross shaft. As a matter of fact the revolution of **E** from the cones hinders the revolu-

tion of the cross shaft. Now, it has been shown by actual calculation that the faster the cross shaft revolved and the slower would the bobbins revolve. The revolution of the cross shaft is therefore a kind of brake or hindrance to the revolution of the bobbins. The chief point now to be understood is that the revolution of the cone drums does not directly speed the bobbins. They indirectly speed the bobbins by reducing the speed of the cross shaft, and thus compelling the latter to be less of a hindrance to the revolution of the bobbins. To put it briefly the cross shaft is a hindrance to the bobbins, and the wheel **E** is a hindrance to the cross shaft. Assuming the speed of the wheels **B**, **E**, as imparted by the cones, to be 300, and the other particulars to be as given previously, the speed of the bobbins may now be calculated when wheels **B**, **E** are making 300 revolutions per minute. It must be distinctly understood that three factors enter into the driving of the bobbins.

- (1) The speed of the bell wheel **C-D** taken as equal to the speed of main shaft, and imparted by the clutch-wheel action of the bevels.
- (2) The reduction of this speed as effected by the axial movement of the cross shaft, caused by revolution of wheel **F** round wheel **E** whilst the latter is stationary.
- (3) The increase of speed as effected by the revolution of wheels **B**, **E** from the cones.

The two calculations previously worked out may be re-stated with the addition of the third, in order to give real speed of bobbins when wheel **B-E** is making 300 revolutions per minute.

$$\begin{aligned}
 & \frac{400 \times 50 \times 55}{37 \times 22} = 1351.35. \\
 & - \frac{400 \times 18 \times 16 \times 50 \times 55}{30 \times 48 \times 37 \times 22} = 1081.1 \\
 & + \frac{300 \times 18 \times 16 \times 50 \times 55}{30 \times 48 \times 37 \times 22} \text{ or, } 202.7 = 1283.8
 \end{aligned}$$

Therefore, assuming the speed of the wheel **E** as imparted by the cones to be 300, the speed of the empty bobbins would be 1283·8 revolutions per minute.

SPEED OF FULL BOBBINS.

As the cone belt moves up the lower cone it is clear that it will reduce the revolution of **B**, **E** as the bobbins increase in size. This means that the plus quantity or calculation **C** is reduced. As **C** is an addition to the speed of the bobbins, it is manifest that the less is this plus quantity, and the slower will be the speed of the bobbins. Taking the speed of **E** at 100 for the full bobbin, the third or plus quantity would be 67·5, and the speed of the bobbins

$$1081 + 67\cdot5 = 1148\cdot6.$$

ADDITIONAL REMARKS.

It is evident that the difficulty is simply to find the velocity of the compound bell wheel **C-D**. This can be obtained at any part of the set from the following formula :

Let v = revolutions of bobbin wheels **C**, **D**.

Let a = „ „ main shaft.

Let b = „ „ wheel **E**.

The value of the jack train of wheels = $\frac{1}{3}$ th as given in table previously.

Then $v = a - \frac{1}{3}$ th of $a + \frac{1}{3}$ th of b .

Or $v = a - \frac{1}{3}$ th of $(a - b)$.

In this motion all the parts revolve the same way as the shaft, as with the other new motions. It must be noticed also that there is least axial motion of the short cross shaft at the commencement of the set, just as in other new motions. At no time is this axial motion high, except, perhaps, just for a moment whilst the ends are run slack for doffing. Everyone of the three pairs of wheels of which the motion is composed revolves slower than the jack shaft. If the motion was applied to a flyer-

leading frame, the cross shaft and the two wheels attached to it would be made to revolve the other way about, and the 50 bell wheel would be reduced to below the size of the 40 spindle driving wheel.

The following article on Tweedale's motion was contributed by the author to the *Textile Recorder* of September 15th, 1896:—

“The present writer has seen several sketches of this motion in which the cross shaft is invariably represented as revolving in the contrary direction to that indicated by the arrows. Seeing that the bevel **E** drives the cross shaft, it certainly appears at first sight as if such would be the case with the bevel **E** revolving in the same direction as the shaft, as indicated by the arrows. The investigations of the present writer have convinced him that such is not the case, but that the cross shaft **G** and its bevels **H F**, at any rate in bobbin-leading frames, always revolve in the direction indicated by the arrows. The explanation is as follows:—The axial motion of the cross shaft **G** and its bevels is obtained from two opposite sources. In the first place, the bevel **E** drives, or attempts to drive it, in the contrary direction to that indicated by the arrows. In the second place, the main shaft, carrying the cross shaft and its bevels bodily round, causes the bevel **F** to roll round the bevel **E** in such a way that the cross shaft is impelled in the same direction as that indicated by the arrows. We have thus two forces simultaneously acting upon and attempting to drive the cross shaft in contrary directions. But the second force is stronger than the first, owing to the superior speed of the main shaft **A** over the speed of the bevel **E**, and the net result is that the cross shaft always has a moderate axial movement in the direction which is indicated by the arrows. Assuming this explanation to be correct, we are forced to the conclusion that it has been erroneously assumed that the bodily movement of the cross shaft caused **F** to simply roll round

E without imparting any axial motion to the cross shaft **G**, and this could never be the case. This may be practically and readily demonstrated by a few turns of an ordinary yarn wrap reel, in which the handle represents the wheel **H**, and the wheel **E** is assumed to be stationary. It will be found that the wheel **F** revolves, and in the direction contrary to that of the arrows. So much for the way in which the cross shaft **G**, and its bevels **H F**, revolve on their own axis. The algebraical formulæ, and the arithmetical demonstrations accompanying the descriptions, are also often inaccurate. To quote, for instance, the most recent contributor to this matter, who, in a contemporary, goes on to say:—‘Suppose **D** to be away, then the shaft **A** carries the wheels **H F** bodily round its own centre, and at a speed of say 400 revolutions per minute. Secondly, the wheel **B** (running at say 350 revolutions) will also cause the wheels **H F** to move round the centre of **A** at 350 revolutions per minute. ‘These two motions, being in the same direction, would give an ultimate number of revolutions, equal to $400 + 350 = 750$ revolutions.’ Now, although we do not think that the wheel **B** would ever run at anything like 350 revolutions per minute, we may say that, according to our ideas, the net result of such an experiment, instead of being 750 revolutions in any way, would be a bodily speed for the cross shaft of 400 revolutions per minute, and an axial speed of 30 revolutions per minute. The cross shaft is always compelled to have the same number of bodily revolutions as the shaft **A**, and the 30 revolutions are obtained as follows:—The wheel **E** (according to the makers) contains 18 teeth, and the wheel **F** 30 teeth, and from these particulars and speeds given we get—

$$\frac{400 \times 18}{30} - \frac{350 \times 18}{30} = 30 \text{ axial revolutions of cross shaft.}$$

The same writer then goes on to give the following formula for obtaining the speed of **D** when actually at

work. "If this be condensed with symbols, where the speed of $A=m$, the speed of $B=a$, the speed of $D=n$, and the ratio between—

$$\frac{E}{F} \times \frac{H}{D} = r.$$

we get—

$$n = m - (m + a)r.$$

By substituting actual speeds and wheels in the formula just given, it will be an easy matter to find the speed of the bobbin wheel C (which is part of D), and from it the speed of the bobbins." To prevent misunderstanding, it may be as well to remember that we are dealing only with bobbin-leading frames, as few, if any, flyer-leading frames have this new motion on. In order to put the above formula to the test, we will substitute actual dimensions, as obtained from a most reliable source—

Number of teeth in wheel E	.....	18
" " F	.....	30
" " H	.....	16
" " D	.....	48
" " C	.....	50
" bobbin shaft spur wheel	...	37
" bobbin shaft bevels	.....	55
" small bobbin bevels	.....	22
" spindle driving wheel	.....	40
" driven spindle shaft wheel		37
" spindle shaft bevels	.....	55
" small spindle bevels	.....	22
Assumed revolutions of B and E for empty		
bobbins per minute	.....	180
Assumed revolutions of jack shaft per minute...		400
The speed of the spindles will be—		

$$\frac{400 \times 40 \times 55}{37 \times 22} = 1081.1 \text{ per minute.}$$

The revolutions per minute of bobbins from foregoing particulars would be found by the formula commonly given, as follows :—

First obtain n , or speed of bobbin wheel **D**—

$$r = \frac{18 \times 16}{30 \times 48} = \frac{1}{5}$$

and—

$$n = 400 - (400 + 180) \frac{1}{5}$$

$$\therefore n = 400 - 116 = 284$$

Then the speed of the bobbins =

$$\frac{284 \times 55 \times 50}{37 \times 22} = 959.46$$

It will be noticed that by this method of calculation we get the bobbins to revolve slower than the spindles, which would be impossible in a bobbin-leading frame, as is here the case. Moreover, this does not result from assuming a wrong speed of the cone-driven wheel **B**, because it would be impossible to drive the cones at a speed which would accomplish the winding. A little thought and investigation of the formula would show that it makes the bobbins go slower when the cones go faster, which is impossible in a bobbin-leading frame. To show this, we will speed up the cones until the wheel **B** makes 220 revolutions instead of 180. We then get speed of bobbins as follows:—

$$n = 400 - (400 + 220) \frac{1}{5}$$

$$\therefore n = 400 - 124 = 276$$

Then—

$$\frac{276 \times 55 \times 50}{37 \times 22} = 932.4$$

We thus reduce the speed of the bobbin by 22 revolutions per minute by speeding the cones, if we are to work by this formula.

Having thus, as we think, demonstrated the inaccuracy of the formula hitherto given, we may proceed to lay down the true formula, based on the assumption that the cross shaft revolves in the contrary direction to that indicated by the arrow. As before, let m represent the speed of **A** the driving shaft, a the speed of **B**, n the speed of **D**, and r the ratio between the wheels, **E**, **H**, **F**, **D**,

$$\text{then } n = m - r(m - a).$$

From this formula we may now proceed to find the speed of the bobbins, taking exactly the same particulars as previously—

$$n=400-r(400-180) \\ \therefore n=400-\frac{1}{5}(220)=400-44=356$$

and—

$$\frac{356 \times 55 \times 50}{37 \times 22} = 1202.6 \text{ speed of bobbins.}$$

To put this new formula to the same test as the other one, we will now, as before, speed up the cones until the wheels **B** and **E** make 220 revolutions per minute, and see whether the new formula gives the necessary increase to the bobbins—

$$n=400-r(400-220) \\ \therefore n=400-r(180)=400-36=364$$

then—

$$\frac{364 \times 55 \times 50}{37 \times 22} = 1129.7 \text{ bobbin speed}$$

or, an increase of 26 revolutions per minute, which is what we should expect from speeding up the cones in this manner, as increasing speed of bottom cone always increases winding power in all makes of bobbin and fly-frames."

[NOTE.—Since writing the above, two of our best writers have altered their descriptions to agree with those here given.]

CURTIS & RHODES' DIFFERENTIAL MOTION.

This motion was the first of the new differential winding motions to be successfully applied to any extent. At the time of writing it can be said in its favour that it enjoys a distinction not enjoyed by any of the other new motions, viz.: It has been somewhat widely applied by firms other than the particular one identified with its invention.

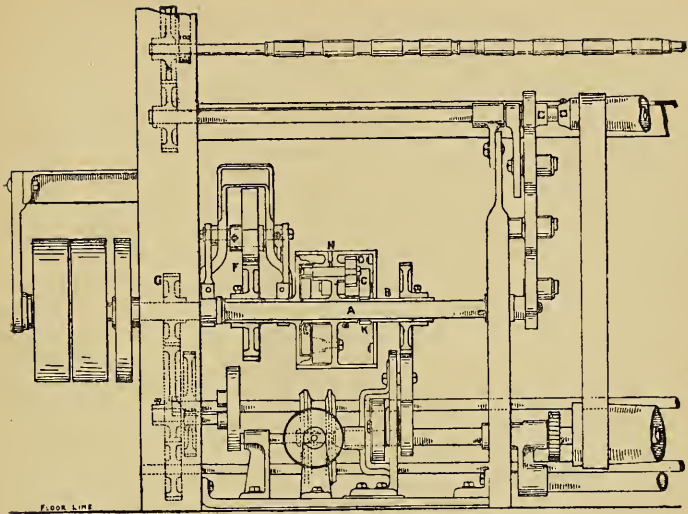


FIG. 56.

DESCRIPTION OF PARTS.

The illustration Fig. 56 shows the motion as applied to a bobbin and fly-frame made by Messrs. Platt Bros., of Oldham. Nothing but spur wheels are used. **A** is the driving shaft, the spindles being driven by wheel **G**, and the bobbins by wheel **F**. As usual the wheel **F** driving the bobbins is loose upon the driving shaft, but is fixed to the long bush of the internal wheel **E**. The disc **H** is fastened firmly to, and therefore runs with, the driving shaft **A**. The connection of the internal wheel **E** to the bottom cone is by means of the train of small spur wheels, the long bush **B** on the driving shaft with small pinion **K** projecting into the box. This pinion drives the pinions **C** and **D**, the stud carrying the pinion **D** having at its other end a small pinion **L** driving the internal wheel **E**, which is

cast to the long collars on which the wheel **F**, which drives the bobbin shafts, is fastened.

WHEN RUNNING ENDS SLACK FOR DOFFING.

As in the case of Tweedale's motion, we will consider first the action of the parts when the bottom cone drum is stopped in order to run ends slack for doffing purposes. At this time, of course, the sleeve **B** and the wheel **K** are stationary. With the wheel **K** stationary, there are two elements of action.

(a) For a moment let it be assumed that the wheel **K** does not exist about the motion at all. Then the disc **H** being fast to the shaft will be carried round with the shaft. As the pinions **C**, **D**, **L** are carried on studs having their bearings in this disc, it follows that the wheels are carried bodily round with the disc, but without any movement on their own axis. The wheel **L** is in gear with the internal wheel **E**, and the two wheels act together as the two halves of a clutch box. Consequently the internal wheel is carried round with the wheel **L** and the disc **H**. Of course, as the bobbin-driving wheel **F** is compounded with the internal wheel, **F** must revolve with the rest of the wheels. Without the pinion **K**, therefore, all the parts of the motion, including the disc **H**, the four small pinions, the internal wheel **E**, and the bobbin wheel **F**, would be carried bodily round at the same speed as the shaft, and in the same direction.

As a matter of fact, however, the pinion **K** is always in gear. Clearly, therefore, because it is in gear the action of the wheels will thereby be affected one way or another. The actual effect is that an axial movement of all the four pinions is set up by pinion **C** revolving round pinion **K**. This axial movement on the part of all the small pinions disturbs the clutch-box action which takes place between pinion **L** and the internal wheel **E**. The revolution of

pinion **L** on its own axis reduces the revolution of the internal wheel **E**, as imparted to it by the clutch-box action. As in the case of the two patent motions previously described, the bobbin-driving wheel **F** is larger than the spindle-driving wheel **G**. Therefore, if both these wheels revolved at the same speed, the ends could not be run slack for doffing purposes, as the bobbins would revolve much more quickly than the spindles. The size of the five pinions and the internal wheel **E** therefore have to be such that their axial movement, induced by revolving round the stationary pinion **K**, will exactly counterbalance and give a loss equal to the gain in bobbin speed obtained by wheel **F** being larger than spindle wheel **G**. The spindles and bobbins will thus be revolved at the same speed. With the exception that there are more wheels, the method of obtaining speed of bobbins when doffing would be identical with the method adopted with Tweedale's motion.

WHEN STARTING A NEW SET OF BOBBINS.

All the four small carrier pinions inside the motion are practically stationary at the commencement of a new set of bobbins. They are carried bodily round, but have little or no motion on their own axis. The best way to understand this is to assume that the sleeve wheel **K** is fast to the shaft, and is therefore compelled to revolve with the shaft. This being so, the action of the parts is as follows:—All the wheels are locked together as if they were parts of clutch boxes. The disc **H** and the pinion **K** are both fast to the shaft, and both act together in taking the four carrier pinions bodily round. As the large internal wheel is locked with the pinions, it also is compelled to go round at the same speed. The bobbin-driving wheel **F** being in one piece with the internal wheel must revolve at the same speed. When bobbin wheel **F** revolves at same speed as spindle wheel

G, the bobbins revolve faster than the spindles, sufficiently to accomplish the winding on the empty bobbin, simply because **F** is larger than **G** in this motion, which never is the case in Holdsworth's motion. This is practically the only element of action to be considered at this stage.

We have assumed that the sleeve wheel **K** was locked to the shaft, and therefore was compelled to go with the shaft. Although this is not the actual case, yet the same effect is produced by the necessary wheels and speeds in connection with the driving of the sleeve wheel **K** from the cones, being calculated to revolve that wheel at the same speed as the shaft and in the same direction when starting a new set of bobbins. The speed of the bobbins, therefore, with the small carrier pinions stationary on their own axis, would be obtained by a speed calculation of the simplest character. The necessary terms would be the speed of the jack shaft, and the number of teeth in the wheel **F**, the end wheel on bobbin shaft, the skew bevels on bobbin shaft, and the small bobbin bevels.

ACTION OF PARTS WHEN MAKING BOBBINS.

We have thus far considered the action of the parts at the two extremes, viz. : the maximum movement of the bobbins, and their minimum movement. As just shown the highest speed of the bobbins is obtained when the carrier pinions are absolutely without motion on their own axis, the latter condition being secured when the sleeve wheel **K** has its highest speed. Previously it was shown how the lowest speed of bobbins was attained when the carrier pinions had their highest axial motion; the latter result being obtained by the sleeve wheel **K** being stationary. Between these two extremes there is a continually varying speed of bobbins, which is attained by having none of the parts stationary, and none of them with their highest rate of motion. The sleeve wheel **K** is started with an initial

speed derived from the cones, about equal to the speed of main shaft. As this speed is lowered by the cone belt travelling up the bottom cone, an axial movement is set up amongst the small carrier pinions, in addition to their bodily movement round with the disc **H**, which disturbs the clutch-wheel action of the pinion **L** with the internal wheel **E**, and reduces the speed of the latter. This reduces the winding speed of bobbins in a degree proportionate to the increase in their diameter. The slower the sleeve pinion **K** is revolved from the cone drums and greater the axial movement of the carrier pinions, and consequently the less the speed of the internal wheel **E** and of the bobbins. The speed of the internal wheel **E** and its other half **F** being known, the speed of the bobbins can be obtained by an ordinary speed calculation. The difficulty consists in getting the speed of the internal wheel **E**. This can be obtained at any time from the following formula :—

Let v = velocity of internal wheel **E**.

Let m = revolutions of jack shaft.

Let n = revolutions of sleeve pinion **K**.

Let a = value of the six wheels inside the motion, which include the sleeve pinion **K**, the internal wheel **E**, and the four pinions connecting these two.

Then $v = m - a(m - n)$.

Or $v = m - a m + a n$.

The following remarks on Rhodes' motion were contributed by the author to the "Textile Recorder" for August 15, 1896:—

"Taking only bobbin-leading frames, in Holdsworth's motion the excess speed of the bobbin over the spindle is obtained entirely from the cone drums, and all the wheels of the differential motion are at their highest speed with the empty bobbins. In all the new motions the excess speed of bobbin is obtained by making the loose bell wheel or bobbin-driving wheel on the main shaft larger than the

spindle-driving wheel. In most cases it is about one-tenth larger than the spindle wheel, as this represents about the amount which the empty bobbins have to revolve faster than the spindles. In some cases, however, it is about one-fifth. The carrier wheels of the new differential motions are at their lowest axial speed (in some cases almost stationary) immediately after doffing, whilst in Holdsworth's motion they are at their highest speed just after doffing. In the latter motion the cones directly impart an increase of speed to the bobbins, whilst in the new motions the cones mostly only increase the bobbin speed by neutralising the effects of an intermediate power, introduced between the cone motion and the main-shaft motion, and which usually takes the form of a clutch arrangement. For instance, in Shaw's motion (Messrs. Brooks & Doxey), Tweedale's motion (Messrs. Howard & Bullough), and Rhodes' motion (Messrs. Curtis and Messrs. Platt Bros.), the carrier wheels all have their highest axial movement when the cone drums are put out of action, whereas at this time the carriers in Holdsworth's motion (bobbin leading) have their lowest axial motion. So far as we know, Rhodes' motion was the first in the field of the new popular motions, and they all overcome the serious defect of having so many wheels to work against the shaft they revolve upon. They do not, however, all overcome the very serious defect of reaction, so prominently developed in Holdsworth's motion.

We propose now to give a formula for finding speed of bobbins in frames which have this motion applied. The following particulars of the motion have been obtained from a reliable source, and may be taken as applying either to slubbing, intermediate, or roving frames:—

Assumed revolutions of shaft **A** ... 400 per minute.

Assumed revolutions of cone-driven wheel K	{	400 just after doffing.
		200 near the middle of the bobbins.

Of course, when the bottom cone is lifted up to throw the ends slack, ready for doffing, the speed of **K** will be nil.

Number of teeth in wheel K	22
" " " C	33
" " in next "	23
" " " D	25
" " " L	14
" " internal wheel E	90
" " bobbin-driving wheel F	72
" " spindle-driving wheel G	65

The speed of the spindles has to be exceeded by the speed of the bobbins by about one-tenth or so just after doffing, and the 72 bobbin wheel is about that much larger than the 65 spindle wheel, so that there is sufficient allowance here to accomplish winding on the empty bobbins without assistance from the differential motion. As a matter of fact, the latter does not assist the bobbin speed, but retards it, and exercises its retarding effect most when the wheel **K** is stationary, and least when it has its maximum speed, just after doffing.

Let the speed of the shaft **A** be represented by m , the speed of **K** = a , the speed of **F** = n , and the ratio between the wheels—

$$\frac{K \times x \times L}{C \times D \times E} \text{ by } r;$$

we then get—

$$n = m - r(m - a).$$

We will apply this formula first to the extreme case of running the ends slack for doffing, when the wheel **K** is stationary, and the speed of **F** ought to work out equal to the speed of the shaft **A**.

$$r = \frac{22 \times 23 \times 14}{33 \times 25 \times 90} = .095$$

$$\text{and } n = 400 - .095(400 - 0)$$

$$\therefore n = 400 - 38 = 362.$$

It will be seen that the speed of n , being 362, is practically $\frac{1}{10}$ less than the m or the speed of the spindle wheel. This about counteracts the difference in size between the wheels 65 and 72, and allows spindles and bobbins to revolve at the same rate.

We will now apply the formula to the other extreme case, viz., with the wheel **K** revolving at same speed as the shaft **A** immediately after doffing—

$$n = 400 - .095(400 - 400) = 400 - 0 = 400.$$

The formula leaves the spindle-driving wheel and the bobbin-driving wheel to be revolving at the same speed, and the bobbins attain their maximum speed by the bobbin-driving wheel being about $\frac{1}{10}$ larger than the spindle-driving wheel.

The formula may now be applied to find the speed n of the bobbin wheel at a period about the middle of the set, say when **K** is making 200 revolutions per minute—

$$n = 400 - .095(400 - 200)$$

$$\therefore n = 400 - 19 = 381 \text{ per minute.}$$

which is exactly midway between the two extreme speeds of 400 and 362.

This formula appears, therefore, to work out satisfactorily for Rhodes' motion.

REMARKS.

In Shaw's motion it has been noticed that the disc is revolved from the cone drums, and is carried round by the wheel **B**, which is fast to the shaft.

In Rhodes' motion it will be seen that the disc is fast to the shaft and carries the wheel with it. This difference in construction apparently allows the re-action from the bobbins to tend to devolve upon the cone belt in Rhodes' motion, whereas it devolves upon the frame shaft in Shaw's motion. It should be a primary object in constructing these motions to have the re-action of the

bobbins always devolving upon the frame shaft. In this motion of Rhodes' experience has proved that there is little wear and tear going on. It is clearly a good thing to have the differential wheels almost stationary at commencement of set, and to have all the parts revolving the same way as the shaft. For flyer-leading frames it is probable that the bobbin driver **F** would have to be made smaller than the spindle driver **G**, instead of the converse, as in bobbin leading. Also the differential pinions would require to revolve the other way about.

MESSRS. DOBSON & BARLOW'S DIFFERENTIAL MOTION.

The new patent differential winding motion, applied by the above firm, is the invention of Messrs. Howarth & Fallows. As seen in Fig 57, the whole motion is so compact that, in outward appearance, it somewhat resembles in size and shape an ordinary shaft-box coupling. The essential principles of the motion are similar to those of the three motions previously described, but the desired objects are attained by considerable differences in construction and arrangement of details.

DESCRIPTION OF PARTS.

Referring now to Fig. 58 upon the driving shaft **A** is a fixed bevel **B**. Gearing into this bevel is a larger one, **C**, which is mounted on a spherical or ball-bearing **D**. The bevel **C** is of a very peculiar construction, and there are also teeth on the back of it which gear into the toothed wheel **S**. This latter wheel **S** is firmly secured to the sleeve of the spherical bearing **D**. The sleeve runs loose on the main shaft, and is extended outside on the box, and upon the outside of it is keyed the bobbin driving-wheel **G**. The wheel **H**, near to **G**, is for driving the spindles;

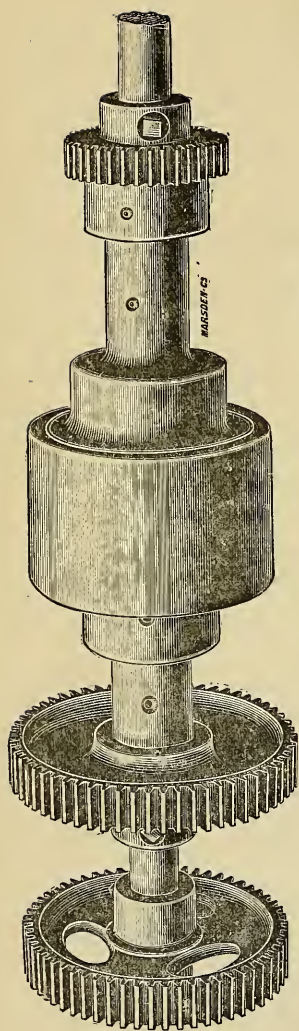


Fig. 57.

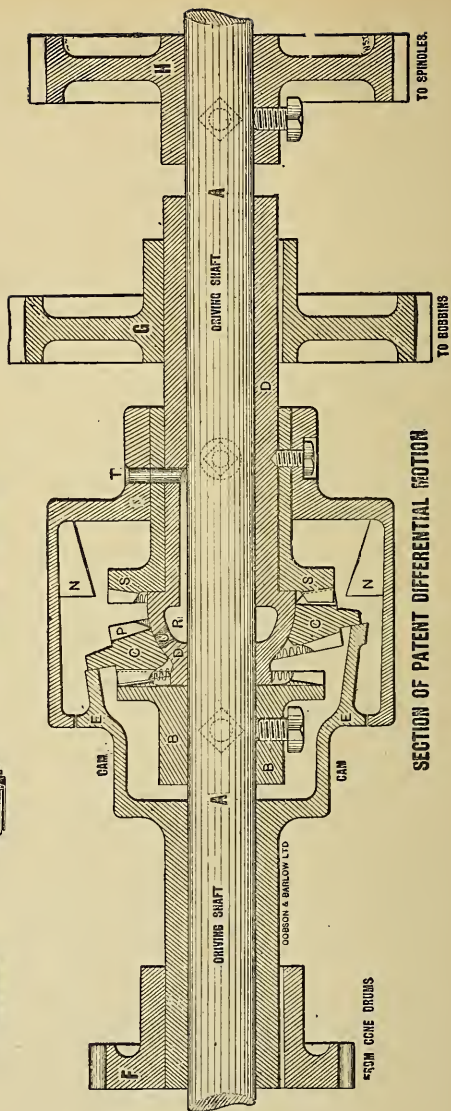


FIG. 58.

and, as in the other new motions, is less than the bobbin wheel **G**. The wheel **F** is driven from the cone drum, and is secured to a sleeve which runs loose on the shaft, and terminates on the other end in a cam **E**. It will be seen that the peculiarly shaped double wheel **C** has a sort of rim, or outside flange, which bears against the working edge of the cam **E**. The cover completes the parts of the motion.

ACTION OF PARTS AT COMMENCEMENT OF SET.

Briefly, the action of the parts considered as if the cam **E** were non-existent, is that wheels **B**, **C**, **S** act together as clutch wheels. The wheel **B** is fast to the shaft and clutches the wheel **C**, and **C** clutches **S**, and, therefore, all the three revolve together at the same speed and in the same direction as the shaft. This arrangement is disturbed when the cam is applied and revolved at a slower rate of speed than the main shaft. At the start of the bobbins, however, the cam **E** is revolved at the same speed as the shaft, and the contact surfaces of the cam **E** and flange of double wheel **C** revolve together, and no friction is set up between them. Consequently all the parts of the motion act as if the cam were really non-existent, and revolve the same way as the shaft and at the same speed. The bobbin wheel **G**, being keyed to the same piece as the spherical bearing **D** and the wheel **S**, of course revolves along with them at the same speed as the shaft, and, therefore, at the same speed as the spindle wheel **H**. As the bobbin driver **G** is larger than the spindle driver **H**, the bobbins are thus made to revolve more quickly than the spindles, sufficiently to accomplish the winding on the empty bobbins. The actual speed of bobbins would be found by a speed calculation, including the size and speed of wheel **G**, and the sizes of bobbin shaft end wheel, bobbin shaft skew bevels, and bobbin bevels.

ACTION OF PARTS WHEN MAKING BOBBINS.

The maximum speed of bobbins obtained in the manner just described must be slowly reduced as the layers of roving are added to them. To effect this reduction of speed the cone belt is moved towards the large end of the bottom cone drum. As this cone drum revolves the wheel **F** and its companion cam **E**, the latter is reduced in speed just in the same proportion as the lower cone. The cam **E** regulates the gearing point of the bevels **B** and **C**, and it follows that directly the speed of the cam is altered the gearing of **B** and **C** is altered. When the cam **E** slows, this gearing point moves backward in the opposite direction to the driving shaft, and the rolling motion thus produced reduces the speed of **C**. This reduction transferred to the bobbin wheel **G** slows the speed of the bobbins. It should be noted that the rolling action of the peculiar-shaped wheel **C** is permitted by its spherical or ball-bearing **D**. It may also be noted that the reduction in speed is effected as in each of the three patent motions previously described, viz., by a negative disturbance of the clutch-wheel action of the bevels **B** and **C**. In resolving the particulars of the motion into a calculation for obtaining speed of bobbins at this time, the only difficulty will be found in obtaining the correct speed of the bobbin-driver **G**.

ACTION OF PARTS FOR FULL BOBBINS.

When the ends are required to be slackened for doffing purposes, the cone-drum belt is slackened as usual, and consequently the cam **E** is stopped. The action thus set up by the cam **E** upon the flange of the double wheel **C** affects the gearing point of **B** and **C** to the greatest extent, and reduces the speed of **C**, consequently of **G**, the bobbin wheel, to the minimum rate. The reduction in speed of bobbin driver **G**, which is thus effected, is sufficient to

counteract the gain in speed of bobbins over speed of spindles, brought about by having bobbin wheel **G** larger than spindle wheel **H**. This allows spindles and bobbins to revolve at same speed, which effects the necessary slackening of the ends.

ADDITIONAL REMARKS.

It will be noticed that in this motion all the parts revolve round with the shaft as an axis, but all in the same direction as the shaft. Reference to Fig. 58 will show that at **T** there is an oil hole which provides for a very efficient lubrication of the various parts. The casing and the cam **E** effectually cover in the whole of the motion, and protect the latter from dirt, and prevent the oil from escaping. It will also be noticed that the parts are few. In a flyer-leading frame the cam **E** would be made to revolve in the opposite direction, and the wheel **G**, for driving bobbins, would be made less than spindle wheel **H**, instead of larger, as shown in Figs. 57 and 58.

The author has had actual personal experience in working this motion, and can testify to its efficiency and light running.

ARITHMETICAL DEMONSTRATION OF MESSRS. DOBSON AND BARLOW'S MOTION.

H	contains	56	teeth.
G	„	63	„
B	„	32	„
S	„	36	„
C	„	36	„ on each side.

Assumed speed of main shaft 300 revols. per minute.

„ size of driven wheel or spindle shaft 40 teeth.

„ „ „ „ bobbin shaft 40 „

„ „ spindle shaft bevels... .. 50 „

Assumed size of bobbin shaft bevels...	...	50 feet.
„ „ small spindle bevels	...	25 „
„ „ small bobbin „	...	25 „

From these particulars ascertain

- (1) The revolutions per minute of the spindles.
 - (2) „ „ „ bobbins when empty.
 - (3) „ „ „ bobbins with cone wheel stopped for doffing.
 - (4) „ „ „ bobbins when half size.
- (1) Speed of spindles equals.

$$\frac{300 \times 56 \times 50}{40 \times 25} = 840 \text{ revolutions per minute.}$$

It will be easy enough finding the revolutions per minute of the bobbins for the three positions above indicated after the bobbin driving wheel **G** has been determined in each case. This we will proceed to do first of all, and the following formula will be of great assistance in doing so:—

Let **R** = revolutions of bobbin wheel **G**.

„ **M** = „ frame shaft **A**.

„ **N** = „ cone wheel **F**.

Then **R** always equals $M - \frac{1}{9} (M - N)$

(2) Revolutions of **G** for empty bobbin, when speed of cone wheel **F** is equal to speed of main shaft **A** will be

$$R = M - \frac{1}{9} (M - N)$$

$$R = \frac{1}{9} (300 - 300) = \underline{\underline{300.}}$$

(3) Revolutions of **G** when bottom cone drum is lifted up to run ends slack for doffing will be—

$$\begin{aligned} R &= M - \frac{1}{9} (M - N) \\ &= 300 - \frac{1}{9} (300 - 0) \\ &= 300 - 33\frac{1}{3} = \underline{\underline{266\frac{2}{3}.}} \end{aligned}$$

(4) Revolutions of **G** when cone wheel is making 150 revolutions per minute will be—

$$\begin{aligned}
 R &= M - \frac{1}{9} (M - N.) \\
 &= (300) - \frac{1}{9} (300 - 150.) \\
 &= 300 - 16\cdot6 = \underline{\underline{283\cdot34.}}
 \end{aligned}$$

The speed of the bobbin driving wheel **G** having thus been determined for each of the three positions, only an ordinary speed calculation is required in each case to find revolutions per minute of the bobbins.

$$(2) \quad \frac{300 \times 63 \times 50}{40 \times 25} = 945 = \text{maximum revolutions of bobbins.}$$

$$(3) \quad \frac{266\cdot0 \times 63 \times 50}{40 \times 25} = 840 = \text{minimum revolutions per minutes of bobbin.}$$

$$(4) \quad \frac{283\cdot34 \times 63 \times 50}{40 \times 25} = 892 = \text{revolutions of bobbin for half size.}$$

Lastly, as we have said, in all the new motions there is a less wheel on the main shaft for driving the spindles than that for driving the bobbins. For flyer leading, in probably all the new motions, these wheels would have to be transposed so as to have the larger wheel driving the spindles, while maintaining exactly the same difference in size. Usually in these new motions there is a small wheel fast on the shaft, acting as driver to another wheel about $\frac{1}{9}$ th or $\frac{1}{10}$ th larger, the same difference in each case existing between the spindle and bobbin driving wheels. In each case these would be transposed for flyer leading. In Dugdale & Davis' motion, which we have not described, the bobbin driver is connected to an internal wheel, in the interior of which works eccentrically an ordinary pinion, which is prevented from rotating round the driving shaft. The eccentric movement of the pinion is controlled by the cones, and the internal wheel and bobbin driver are advanced or retarded in proportion to the number of teeth in the internal wheel in excess of the teeth in the pinion. We believe Messrs. Tweedale & Smalley, of Castleton, have produced a motion which is a modification

of Holdsworth's. It has, however, the bearings of the intermediate bevels fixed to the shaft, and the fixed bevel of Holdsworth's motion is loose in this new motion, and is driven from the cone drums.

CHAPTER IX.

DRAWING BY ROLLERS.

ON ROLLER SETTING.

The remarks now to be made upon the important subject of roller setting will not be confined entirely to the rollers of a draw-frame. Speaking generally, the importance of having the different pairs of rollers at a correct distance from each other, centre to centre, can scarcely be over-estimated. It is one of the conditions that a practical man should constantly watch and maintain. Particularly is care necessary when the staple of cotton is often varied in length and harshness. The author, in common with other practical men, has frequently witnessed the worst results accruing from incorrect and careless setting of rollers. In all the machines the most important point at which the setting of the rollers must be checked and watched, is between the front and next to front rollers, *i.e.*, between the front and middle rollers wherever there are only three pairs of rollers. This is chiefly because of the greater draft or attenuation of the cotton which takes place here than anywhere else. There are quite a number of circumstances which affect the correct working distance of the rollers from centre to centre. The leading principle of all is the length of the staple or fibre of the cotton. Longer the cotton and further apart must the rollers be set, and shorter the cotton and closer the rollers. Except in special cases to be

hereafter specified the rollers should never be set closer together from centre to centre than the length of staple in order to produce the best results. Referring more particularly to the processes beyond the slubber, the distance from centre of front roller to centre of middle roller should just exceed the length of staple, that is, just as the middle rollers are releasing the fibres, the front rollers should take hold of them. At the mule or ring-frame, for instance, this distance may be from $\frac{1}{3}\frac{1}{2}$ in. to $\frac{1}{8}$ in. more than the length of staple. As we examine the machines backward from the mule or ring-frame, we shall find that the distance from centre of front roller to centre of middle roller slightly increases successively at every machine until the slubbing and draw-frames are reached.

This is because of a second leading principle regulating the setting of the roller distances, but yet of less importance than the length of staple. It may be stated thus. Thicker the sliver or body of cotton fibres that are being operated on, and greater may be the distance from centre to centre of the rollers. This principle is evidenced by the differences in diameter between the rollers in the spinning room and in the cardroom, which precludes the cardroom rollers from being set as close as the rollers on the spinning machines. Taking for instance the two extremes, the diameter of a draw-frame front roller for American cotton is often $1\frac{3}{8}$ in., whereas for the same cotton on the mule it is commonly 1 in. A little reflection will make it clear that when a thick body of fibres are being drawn out, the fibres will have a stronger tendency to support one another, and adhere to one another, than when a thin body of fibres are being drawn.

A third leading principle which affects the distance, apart of the rollers, is the amount of draft that exists between any two pairs of them. Less the amount of draft and greater may be the distance from centre to centre. A very little amount of thought will be needed to convince

anyone that if no draft whatever existed between two pairs of rollers, it would have little or no effect on the staple of the cotton, whatever distance there was between the two pairs. If all the rollers revolved at one surface speed, the cotton would simply be carried forward, and there would be scarcely any tendency for the fibres either to fall out or be injured. This is the chief reason why, in all the machines, we can afford to have the back pairs of rollers further away from one another than the front pairs. If we had the same distance between the latter as the former, many of the fibres would fall out, and the material would be unevenly drawn. The three principles just enunciated are, in the writer's opinion, by far the most important of any that effect the setting of the rollers. There are, however, a number of other points that affect the distances, apart from the rollers, to a minor degree. For instance, the amount of twist put in the roving must have some small effect on the roller distance. If more twist be put in, it will have a tendency to allow the rollers to be a little further apart, as they adhere to each other more. It is, however, highly improbable, in the author's opinion, that in actual practice any alterations in twist would ever be made of sufficient extent to compel an alteration in the setting of the rollers; at any rate, if no radical changes were at the same time made in the quality of the cotton and in the counts spun.

Again: It is well understood amongst practical men that, as far as practicable, we should avoid having long and short cotton fibres working together, as such a procedure is highly conducive to the production of crackers in the yarn by the short fibres issuing from the rollers first, and twisting round the long, and also to cause injury to the fibre. When long and short cottons are mixed together, if the rollers are set for the short fibres, the long are broken; and on the other hand, if set for the long, there is a tendency for the short to fall out in the

ordinary process of working. Assuming, however, that long and short fibres are mixed together, there is one practical method of procedure by which we can effect a sort of compromise in the matter and produce a moderate quality of yarn. One or two pages back we stated that if little or no draft existed between two pairs of rollers, we could afford to set them wide apart. In the case of mixing long and short cottons together we might use this principle as follows: Make the roving as fine as ever it is practicable, and by this means only a comparatively small amount of draft will be necessary in the rollers of the spinning machine. We can thus afford to set the latter rollers a little wider apart so as to avoid breaking the fibre, and yet not have much short fibre fall out, and at the same time to be less liable to make crackers. Self-weighting of middle roller is, however, the best remedy. Other minor points that may effect the roller distances and their drawing power are the speeds of the machine, the sharpness of the flutes, the length of boss, the amount of weighting, whether the cotton be soft or harsh and wiry. It may be repeated again, however, with emphasis, that the three great leading principles are:—

- (1) The length of staple.
- (2) The thickness of the sliver or roving.
- (3) The amount of draft in the rollers.

In the spinning machines we might almost venture to regulate the setting of the front and middle rollers solely according to the length of staple, making it a rule to set here just beyond the length of fibre. The following table gives an approximate idea of the roller distances and diameters for different cottons on the draw-frame:—

DIAMETERS OF STEEL ROLLER IN INCHES.

Cotton.	1st. or Front Roller.	2nd. Roller.	3rd. Roller.	4th. or Back Roller.
Sea Islands.....	$1\frac{1}{2}$...	$1\frac{1}{4}$...	$1\frac{1}{2}$...	$1\frac{1}{2}$
Egyptian ..	$1\frac{1}{2}$...	$1\frac{1}{4}$...	$1\frac{1}{2}$...	$1\frac{1}{2}$
American.....	$1\frac{1}{4}$...	$1\frac{1}{8}$...	$1\frac{1}{4}$...	$1\frac{1}{4}$
Indian	$1\frac{1}{8}$...	1 OR $\frac{7}{8}$...	$1\frac{1}{8}$...	$1\frac{1}{8}$

APPROXIMATE DISTANCES FROM CENTRE TO CENTRE OF
STEEL ROLLERS IN INCHES.

Cotton.	Front and 2nd. Rollers.	2nd. and 3d. Rollers.	3rd. and 4th. on Back Rollers.
Sea Islands.....	$1\frac{5}{8}$...	$1\frac{3}{4}$...	$1\frac{3}{4}$
Egyptian	$1\frac{1}{2}$...	$1\frac{5}{8}$...	$1\frac{3}{4}$
American.....	$1\frac{1}{4}$...	$1\frac{3}{8}$...	$1\frac{1}{2}$
Indian	$1\frac{1}{8}$...	$1\frac{1}{4}$...	$1\frac{3}{8}$

It will be understood that the above dimensions are slightly varied according to circumstances.

Generally the top rollers will be about $\frac{1}{4}$ in. less in diameter than three lines of the bottom rollers before the leather covering is put on the top rollers, so that even with the leather included, they are less in diameter than the iron rollers. Often they are a shade thicker than the second roller when the leather is put on. It will be noticed that longer staples of the better classes of cotton enable us to employ larger diameters of rollers. Also that the second roller is always less in diameter than the others. This is so in the other machines, and is done in order that we may set the first and second rollers closer together than would be possible with this second roller the same diameter as the others.

When rollers are too close, a practical man will generally notice it very soon by the rollers "spitting" or "spewing" the material out in hard, thick, undrawn pieces at intervals. One very sure piece of evidence that the

rollers in the cardroom, and spinning machine as well, are too far away is that the yarn, if wrapped round a black surface, will appear uneven, and will show small white lengths intermixed with thinner and darker lengths of yarn. It is a very common plan with some practical men to test the length of the cotton fibre in the cotton chamber, in order to gauge the distance apart his rollers should be. This is all very well and proper, but it is also advisable that the length of staple should be ascertained as far as practicable as contained in the sliver, etc., made at the different machines. This is because of the thin, weak ends of the cotton fibres being very liable to break off in passing through the various machines, and thus shortening the length of staple. In all cases our roller setting should always be checked by watching the action of the machines and the quality of the material made. An important item in connection with the setting of the rollers is to have ready means of adjustment provided. The author has been in at the setting of rollers that required the use of a specially-formed cap key, and which could only be adjusted with a great amount of very jading labour. In all cases the cap bars should be made so as to allow of very ready and accurate adjustment. The usual method of adjusting the rollers is to have a wooden, brass, or iron gauge of the required thickness, which is passed between the rollers, and to screw up the cap nebs when the gauge is just easy between the rollers. There has been a very distinct improvement of late years in the construction of the cap nebs.

The following are diameters of rollers and distances apart suitable for a roving-frame:—

APPROXIMATE ROLLER DISTANCES AND DIAMETERS. (<i>Drawing Frame</i>)				
INDIAN.	AMERICAN.	EGYPTIAN.	SEA ISLANDS.	
<i>Diam 1/8</i>	<i>Diam 1/4</i>	<i>Diam 1/2</i>	<i>Diam 1/2</i>	<i>4th or Back</i>
<i>12 1/2"</i>	<i>1 1/2"</i>	<i>13 1/4"</i>	<i>17 1/8"</i>	ROLLER
<i>Diam 1/8</i>	<i>Diam 1/4</i>	<i>Diam 1/2</i>	<i>Diam 1/2</i>	<i>3rd</i>
<i>11 1/4"</i>	<i>1 2/3"</i>	<i>15 1/8"</i>	<i>13 1/4"</i>	ROLLER
<i>Diam 7/8</i>	<i>Diam 1/3</i>	<i>Diam 1/4</i>	<i>Diam 1/4</i>	<i>2nd</i>
<i>11 7/8"</i>	<i>1 1/4"</i>	<i>9 1/2"</i>	<i>15 1/8"</i>	ROLLER
<i>Diam 1/3</i>	<i>Diam 1 3/8</i>	<i>Diam 1/2</i>	<i>Diam 1/2</i>	<i>1st or Front</i>
				ROLLER

FIG. 59.

ON DRAFTS.

By draft is here meant the drawing out or attenuation of the material at any machine. Suppose, for instance, one inch of sliver is put behind a slubber and drawn into four inches by the action of the slubbing-frame rollers, there is said to be a draft of four in the rollers. Drafting may be said to be one of the most important principles of cotton spinning. By it the heavy lap is drawn into the comparatively thin sliver on the card, and the sliver is finally reduced to the fine thread of yarn. The driving of the rollers on a drawing-frame has been subject to considerable

variation, and there are several methods in use at the present time. This is because the drawing-frame contains four lines of drawing rollers, whereas the spinning machines and all the bobbin and fly-frames contain only three pairs of rollers, and there is only one method of driving them on all the machines enumerated. In these machines the front roller drives the back, and the back drives the middle roller invariably.

Glancing at the different methods in vogue of driving the rollers on a drawing-frame, it may be said that the most common and popular method at present in vogue is that exhibited in the drawings of Messrs. Brooks & Doxey's frame given in Figs. 8 and 9. Here it is seen that the front roller drives the back exactly as on a mule. Then the back roller drives the next to it in exactly the same way as on a mule, *i.e.*, a small pinion on the back roller drives a still smaller pinion on the next roller to it by the intervention of a carrier. Close to these wheels there is another connection of an exactly similar character, by which the back roller drives the next roller to the front.

A second method, as made by Messrs. Howard & Bullough, is exhibited in Fig. 60. This system they consider the most convenient, and it is applicable to frames either with the electric or the mechanical stop motion. The arrows indicate the direction of motion. The breakd raft is between second and third, instead of first and second. The largest of the three drafts being put here instead of at the front greatly reduces the licking of the fibres on the front and second rollers.

A third method has the third roller from front driven from the front roller exactly as on a mule or fly-frame, and then the third roller from front drives the second by one connection, and the fourth or back roller by another connection.

A fourth method has the back roller driven exactly as in a mule or fly-frame, *i.e.*, by means of a front roller

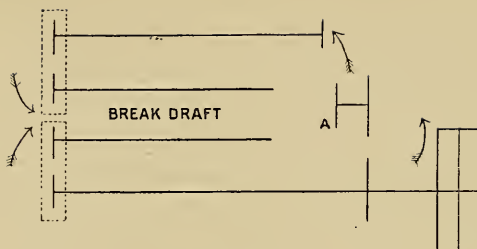


FIG. 6o.

pinion, a crown wheel, a change pinion, and the back roller wheel. The back or fourth roller then drives the third, and the latter, by a similar connection, drives the second.

A fifth method has the second roller driven from the first or front as in the second method, but at the other or gearing end the third roller is driven from the front, and then the third roller drives the fourth or back roller.

A sixth method has the third roller driven from the first or front roller at one end. At the other end the first roller drives the second roller, and the second roller drives the fourth or back roller.

These six systems can be really classed into two divisions. First, those in which an alteration in the change pinion will cause the necessary variation in draft to take place between the first and second rollers. The first, third, and fourth methods are of this kind. It will be seen upon examination that in these cases if a larger change pinion is put on, the second, third, and fourth lines of rollers will all be speeded, and the first line will revolve at the same speed, with the result that less draft will take place between the first and second rollers. In the second division we have the second, fifth, and sixth methods. In these cases the break draft is not between the first and second rollers. For instance, in method number two, if

the change pinion **A** be enlarged, the third and fourth lines of rollers only will be speeded, and the first and second lines will remain unaltered. The result is a less amount of draft between the first and third rollers. The author himself is in favour of the styles in division the first. He gives it as his own opinion that the break draft should be between the first and second rollers in all cases. To give an illustration. In the style of driving as described in method six, a case came to the author's knowledge in which the change pinion had been so enlarged as to make the fourth go faster than the third roller, and so destroy the draft between these two rollers entirely. This was only discovered upon a thorough investigation of the frame, caused by the quality of the sliver being very unsatisfactory. This could never happen where the break draft is between the first and second rollers.

Again: The draft at this point is always greater than elsewhere, and will, therefore, allow of more variation. This is only one case in point. Quite a number could be cited showing how disastrous results have been produced by the intermediate drafts of a draw-frame being tampered with. Often this has been done deliberately by uninformed persons in order to secure some slight change of counts, or as a matter of convenience. The intermediate drafts between the second and third, and third and fourth rollers, should be set out at first by competent persons, and unless some considerable change in counts takes place, they should afterwards be left alone. Pursuing this idea still further some men, in the author's opinion, have on the other hand produced disastrous results by leaving them alone in big changes when it would have been better to skilfully and intelligently re-adjust them. This remark does not apply to the draw-frames only, but to the fly-frames and the mule. Of late years there has been a strong movement on the part of American spinners to convert their machinery

to Egyptian cotton and much finer counts of yarn. In many such cases it has not been thought of sufficient importance to change the draft between the back and middle rollers on the mule, and in the fly-frames and draw-frames. This, in the author's opinion, is a mistaken practice, and particularly on the mule, when, in addition to the counts being made finer, double roving has been resorted to instead of single, thus necessitating a change from a total draft of about eight to a total draft of about thirteen. The author has known such cases where the mule spinning has been wretched, and the middle iron rollers have been nicked and cut dreadfully by the spinners having to use knives to cut off the laps that were continually accumulating on these rollers. The rollers have been pumice-stoned and put closer, and otherwise treated in order to remedy the attendant evils, but all to little effect. All the time the draft between the back and middle rollers on the mule has been about 1·10, or just the same as when the total draft in the rollers was eight. Because of the bad yarn, the bad spinning, and the middle iron roller laps, the finer numbers, in which the draft was excessively large, had to be discarded. Now, if the draft between back and middle rollers had been increased from 1·10 to about 1·3 or so, the draft between the front and middle rollers could have been lessened considerably. The author believes there would be greatly improved results, both in spinning and in quality of yarn produced in such cases, by the adoption of the principle he has just described, although with rollers properly adapted for big drafts, he would strictly adhere to the low back-draft. A practical and systematic rule that the author has worked upon in changing to much finer numbers has been as follows:—

For three lines of rollers, first divide the old and smaller total draft into the new and larger total draft. Extract the square root of the quotient. Multiply this square root into the former draft between the back and middle rollers,

and the product will be the new total draft between the back and middle rollers. Applying this rule to such a case as above-mentioned, in which we change from eight total draft single roving to thirteen total draft double roving, we get :—

$$(a) \frac{13}{8} = 1.625$$

$$(b) \sqrt{1.6250} = 1.27$$

$$(c) 1.16 \times 1.27 = 1.4732$$

draft between back and middle for 13 of a total draft, when 1.16 was correct for a total draft of 8.

This would reduce the draft between front and middle rollers from

$$\frac{13.00}{1.16} = 11.2$$

$$\text{to } \frac{13.0000}{1.4732} = 8.82$$

Any manager or carder who wished to carry out the same systematic change in the draw-frames, which have four lines of rollers, could work according to the following rule, which is similar to the above, but would be less likely to be required, as the draw-frame total draft ought not to be altered much. Suppose we do change to a larger total draft. As before, divide the old total draft into the new total draft. This time, however, instead of obtaining the square root of the quotient, we must obtain the cube root. Multiply the old draft between the third and fourth rollers for the new draft at this point. Also multiply the old draft between the second and third rollers for the new draft at this point. If these two drafts are made correct, the draft between the first and second rollers will take care of itself.

It has been deemed best to discuss the whole subject of drafts in one general article in preference to splitting it up into detached remarks in different parts of the book.

The simple rule for finding total draft on bobbin and fly-frames and the spinning machines is as follows:—Divide the product of the front roller pinion, change pinion and diameter of back roller into the product of the crown wheel, back roller wheel, and diameter of front roller. It really is the same thing as finding the revolutions of the front roller to one revolution of the back roller, if we assume the back and front rollers to be one diameter, as they commonly are.

Example.—F.R.W., 20; Crown W., 90; C.P., 40; B.R.W., 55. Diameter of front and back rollers each one inch. Find draft.

$$\frac{90 \times 55 \times 8}{20 \times 40 \times 8} = 61.8.$$

If the change pinion be left out of the calculation, we obtain the constant number for draft.

Example—

$$\frac{90 \times 55 \times 8}{20 \times 8} = 247.5$$

If this constant be divided by any draft it is desired to put in, we obtain the necessary change pinion.

Example.—Find change pinion required to give 5.5 of a draft.

$$\frac{247.5}{5.5} = 45 \text{ change pinion.}$$

If the constant be divided by any change pinion, the answer will be the draft which such pinion would give.

Example.—Find total draft which a 35 change pinion would give.

$$\frac{247.5}{35} = 7.07 \text{ draft.}$$

To find the draft between back and middle rollers we may multiply pinion or middle roller into diameter of back

roller for a divisor, and for a dividend take the product of the pinion or back roller into diameter of middle roller.

Example.—Diameter of back roller or roving frame, $1\frac{1}{8}$; diameter of middle roller, 1"; pinion on middle roller, 16; pinion on back roller, 21. Find draft between the two.

$$\frac{8 \times 8 \times 21}{9 \times 8 \times 16} = 1.16$$

If the total draft be divided by this answer it will give draft between front and middle rollers.

In five out of the six methods of driving the rollers of a drawing frame which are elsewhere described in this treatise, the draft between the third and fourth lines of rollers can be found by the rule given above, if we in each case regard the third roller as being the middle. The exception is where the third roller is driven from the front at one end, and there is no direct connection between the third and fourth lines. The draft between the second and third rollers is obtained in various ways, according to the style of driving.

As an example, we may take the first and most common method of driving. In this case the draft between the second and third rollers is found by dividing the draft between second and fourth by draft between third and fourth. The draft between the second and fourth is found by taking for a divisor the pinion on second roller, diameter of back or fourth roller, and for a dividend the pinion or back roller $\times$ diameter of second roller. The draft between first or front rollers and the second rollers is found by dividing draft between back and second rollers into total draft.

Between the four lines of drawing frame rollers there are three intermediate drafts, back, middle, and front, which, all multiplied together, give the total draft. If any person desired to re-arrange these intermediate drafts on a new basis the following would be an approximate method only of doing this:—

Extract the cube root of the total draft, and take this cube root as the middle draft of the three. Extract the square root of this middle draft, which will give an approximate back draft. These two drafts multiplied together and divided into the total draft will give the front draft. It must be distinctly understood that this is only an approximate method.

A method may be given of dividing the total draft in any four of the processes into certain parts, according to any required proportion. For instance, suppose the total draft from the slubber to the mule, inclusive, be 980, and it is required to divide this out into the proportions of $3\frac{1}{2}$, 5, 6.5 and 8.5 drafts respectively in the slubber, intermediate, roving, and mule.

Rule.—Multiply all these four supposed drafts together. Extract the fourth root of the product, and also of the required total draft. Multiply the latter answer by any one of the above supposed drafts, and divide by the former answer, or biquadrate root of product of the four supposed drafts. The answer in each case will be the correct draft at the machine whose supposed draft is taken.

The same rule holds good if three machines are taken instead of four, only that the cube roots of the two total drafts must be extracted instead of the biquadrate roots. To find the total draft in any number of machines we may multiply all the individual drafts together. For instance, if there be four in the slubber, five in the intermediate, 6.5 in the roving, and 8.5 in the mule, the total draft in these machines = $4 \times 5 \times 6.5 \times 8.5 = 1105$.

Another rule for the same thing is:—Multiply the total number of doublings in the several machines into the counts being spun, and divide by the hank slives put up behind the slubbing frame.

Example.—Suppose the hank sliver be .15, and the counts spun be 36's with the usual number of doublings and single roving at the mule:

$$\frac{36 \times 2 \times 3}{\cdot 15} = 960 \text{ total draft.}$$

It may just be remarked here that the combination of quick speeds and big drafts should always be avoided, if anything like good work is to be obtained. In particular does this remark apply when the cotton is poor, or if it be of irregular staple. In the latter case, more especially, because small drafts will enable us to open the rollers wider, and thus to effect a sort of compromise with the mixture of long and short fibres.

Long stapled cottons of course will allow of greater drafts than short cottons, and, indeed, in the former case, the larger drafts are essential, in order to obtain the requisite fineness of counts. As is well known, in low numbers, one of the three usual bobbin and fly-frames is often dispensed with, whilst in very fine counts a fourth bobbin and fly frame is used. Approximate methods have just been given of proportioning out amongst these machines the total draft required, and the amount of draft put in any one machine will chiefly depend upon the number of machines employed and the fineness of the yarn required and the number of doublings. It is injurious to the fibre to have a very small draft in one machine, and to compensate for it by having a very large draft in another machine. In proportioning our drafts out, however, some regard will have to be paid to having one lot of machines to keep up with another. For instance, if the roving-frames cannot keep up with the spinning machines, it could be managed probably by lessening the draft in the roving-frame, and increasing it in the rollers of the spinning machine to a like proportion.

We have said that rollers should not be set inside the staple, that is, the distance from centre to centre of adjoining rollers should not be less than the length of cotton fibre. There is, however, one very notable exception to this rule in connection with the spinning of fine numbers

on the self-acting mules. In this case the distance from centre of front iron roller to centre of middle iron roller is often less than the length of staple. For instance, we have actually gauged the distance in a few cases where there has been only $1\frac{1}{3}\frac{1}{2}$ inches distance for cotton, with almost $1\frac{1}{4}$ inches staple. This is regularly done in the spinning of medium fine numbers from Egyptian cotton, double roving. The reason for the close setting is largely to prevent middle iron roller lapsowing to the very large "draft" or "breakage" between the front and middle rollers in such cases. This close setting is possible in these cases without materially damaging the fibres or causing "spewing," because of the fact that the weight is taken off the middle roller, and often it is uncovered with leather. Often a top middle roller for two ends will only weigh $\frac{1}{4}$ lb., which is equal to putting $\frac{3}{4}$ lbs. of weight upon 6 ends, as against 5 lbs. for 6 ends with the lever method of weighting, as practised for American cotton. It follows from the little weight placed on the middle roller that the draft between back and middle rollers must be kept down, a good draft at this point being about 1.11 for a total of 11 or so. Although recommending this low back draft for dead weighting, we recommend a somewhat larger back draft with lever weighting with the same total draft, simply because in the latter case the middle roller has more drawing power.

LEATHER COVERED TOP ROLLERS.

The leather covered top rollers may be of the fast boss or loose boss type; of the single or double boss type; or, as in some recent draw frames, may be fast or solid rollers, and have the ends or pivots working in loose bushes.

FAST ROLLERS.

Fast rollers, with double bosses, were at one time almost universally employed, and were usually weighted

in the middle as are mule rollers. These rollers are divided into two equal parts, each part performing equal duties with the other. Sometimes they are weighted in the middle, and sometimes at either end on the draw frame. On the speed frames they are always weighted in the middle. The fast roller is all one solid casting, with the neck and the ends or pivots and the body of the proper sizes and shapes. The flannel and leather coverings are, of course, afterwards applied.

LOOSE BOSS ROLLERS.

These were invented by the late Mr. Evan Leigh, and are now almost universally employed for the front lines of rollers in the draw-frame, and also very frequently for the front rows on the fly-frames. Occasionally also they are employed for the second, third, and fourth rows of rollers, but not very often. In these rollers the two bosses, or leathered-covered portions of the roller, are placed loose upon the shaft or spindle part. Because of this distinctive feature they are often termed shell rollers. The shaft is of a barrel form, and so shaped that each shell only rests upon the spindle or shaft at one limited portion. The shells are in contact with the iron rollers, and, therefore, revolve, whereas the spindle is stationary.

COMPARISON OF THE SOLID AND SHELL ROLLERS.

The loose bosses are somewhat more expensive in the first instance. The ends of the rollers and the middles being stationary, do not accumulate fly and dirt anything like as much as with fast rollers. Chiefly on this account the lubrication of the shell rollers is much superior to the fast rollers, as the fly cannot very well get to the point of frictional contact between the spindle and the shell. There is not much difference in the long run in the trouble of cleaning and oiling the two kinds of rollers. Certainly

with the solid rollers the ends and centres have to be more frequently attended to than with shells. On the other hand, in order to clean and oil the shells effectively, they have to be taken out at intervals and the shells pulled off the spindles while the latter are cleaned and oiled. The labour and time involved in this operation often lead to its neglect on the part of careless operatives. Neglect of oiling and cleaning the rollers, with either system, cannot fail to cause heating of the rollers and imperfect drawing and bad work. The author would also like to say a word at this point upon the danger of using poor oil—for shells in particular. With some sorts of oil he has noticed the shells to be disgracefully dry and dirty when stripped for cleaning, although only the regulation time has elapsed since the rollers were cleaned before. With better oil the rollers have often been allowed to run longer with impunity. If either solid or shell rollers are retarded by any cause, then the fibres are crushed and weakened by the rubbing they receive. Also the slivers will tend to break and to come out uneven. Sometimes the oiling is so carelessly performed as to have the oil daubed all over the leather.

It would appear that heavier weights are necessary for shell rollers than for solid rollers in order to perform the attenuation of the material satisfactorily, but we have not found much practical disadvantage to result from this. The author is certainly in favour of shell rollers for the front line of rollers for draw-frames, for speed-frames, and also for the spinning machines with not less than three threads to a boss. On the latter machines he has witnessed exceedingly troublesome results with loose bosses to very short rollers. If the utmost possible care has not been exercised to have the pair of shells on the same spindle or arbor of the same thickness when covered, the thicker boss has raised the thinner one slightly off the iron roller, allowing the pressure to be only at one end of the thin boss, and resulting in imperfect drawing and continual breakages

of threads. Care should always be exercised in pairing the leathers, but irregularities manifest themselves a great deal sooner in short than in long bosses. Anyone who will mark the two halves of a shell roller will soon see the marks leave one another when the machine is started.

LOOSE BUSHES OR PIVOTS FOR TOP ROLLERS.

A still more recent style of top roller than the loose boss has for some time been successfully applied to drawing frames by at least one firm. In this new method the rollers are solid, but the pivots, or ends, work in loose bushes in such a manner that fly and dirt cannot accumulate on the pivots. This practically removes one of the chief objections to the solid roller. In addition, they afford facilities for being more easily, quickly, and cleanly oiled than loose bosses, because the latter have to be taken out for that purpose, which is not the case with the loose pivots, as the latter can be oiled with the frame working.

SINGLE BOSS ROLLERS.

These have latterly largely displaced double boss rollers on the draw-frame. They require less roller leather somewhat, as 8 or 9 inches is the full width of the leather required for a $15\frac{1}{2}$ or 16 inches roller, whereas each half of the single boss roller requires leather about 5 inches wide. In one sense, having leather about $8\frac{1}{2}$ inches wide is a source of evil, as, on account of roller leather varying in thickness in the same skin, the coverer must be careful not to have varying thicknesses of leather on the same boss. As double boss rollers were generally weighted in the middle, there were less hooks, wires, and weights than with the weighting at either end, always necessarily practised with the single boss rollers. The latter method, however, with the long rollers of a draw frame, is preferable, and more likely to produce good yarn than weighting in

the middle, as a more uniform pressure is exercised on the fibres. Also, with single bosses the slivers that are doubled together seem to be consolidated together, and not to have the same number of selvages.

WEIGHTING OF TOP ROLLERS.

On bobbin and fly-frames it is common to have dead weights for the top rollers, say, one 20lb. weight for front roller, and one 16lb. weight divided between back and middle. On draw-frames, also, the more common plan is to have dead weights, but in some cases lever weights are used, the levers being generally laid lengthways parallel with the roller beam, and one lever acting for first and second rows of rollers, and another lever for third and fourth.

The great point in favour of lever weighting is, that it is easy to adjust the weight nearer to or further away from the fulcrum, in order to vary the weight on the rollers. If the hank sliver is liable to be varied considerably, this is an advantage, as it is a somewhat costly matter to obtain a complete fresh set of dead weights. The drawing frame tenters, however, can scarcely be expected to keep the weights in their proper nicks in the lever, and to keep the fulcrum of each lever as accurately adjusted as is done by self-actor minders on the mule. Chiefly for this reason the author is of opinion that dead weights are the better in the great majority of cases, although in some districts there are very many frames fitted with the lever system.

ROLLER TRAVERSE MOTIONS.

The subject of roller traverse motions has occupied much attention on the part of machine makers and cotton spinners during the last few years. The objects sought have been to save wear and expense in roller leather, and to improve the quality of the finished yarn. The primary

object of all roller traverse motions is to prevent the rovings always working and wearing at one point on the roller leather. Some of the roller traverse arrangements that were long in use certainly required improvement. Times without number the author, in common with other practical men, has witnessed trouble and bad work through imperfect traverses. For instance, in some of the older traverse motions, absolutely no provision was made for varying the sweep of the traverse, which was a very grave fault indeed. In such cases, when the machinery has been stopped for week ends and other causes, there has been the greatest difficulty in getting the machines properly started, simply because the rovings kept running off at the roller ends and middle. Sometimes they would run off at one end of the roller, and would be altered to work a little to the other end, with the result that the evil was simply transferred to the opposite ends of the rollers. Often screw-keys have been savagely thrown down and hard words uttered from this cause alone. All traverse motions used in this connection are examples of the conversion of rotary or circular motion into reciprocating or rectilinear motion. Readers familiar with the principles of mechanics will know that there are several methods of doing this. Such, for instance, as mangle wheel motions, escapements, cranks and cams, or eccentrics. Roller traverse motions, as used in cotton mills, seem to belong invariably either to the crank or to the cam or eccentric type.

SIMPLE CAM OR ECCENTRIC.

This has long been the most extensively employed of any, and when well constructed and the parts in good order is very effective. The shape of the cam is varied according to the ideas of the makers. Usually a worm on the back roller drives a worm wheel at a very slow speed. Compounded with the worm wheel is an edge cam which

presses against a short lever, to which wheel is connected the guide bar, for the roving, by a connecting rod. A spiral spring keeps the short lever or stud pressed against the cam. The cams may be laid face up or put vertically, at the caprice of the maker, but the result is the same in each case.

SIMPLE CRANK TRAVERSE MOTION.

In this style, instead of compounding a cam with the worm driven by the back roller as described above, a simple crank takes the place of the cam. The crank arm is connected to the crank stud at one end, and to the guide bar at the other end, and no spring is necessary, as with the cam. One of the greatest advantages of this method in the author's opinion, is the firmness of the movement imparted to the guide bar, resulting in the absence of loss of motion at the change of traverse. Its greatest defect, in the author's opinion, is, that the motion imparted to the guide bar is not only variable, but that the bar moves most quickly in the middle of the roller boss and most slowly at the ends of the traverse. Unless the crank has a comparatively quick revolution, when it is passing the dead centres there will be a tendency for the rovings to run off at the ends of the rollers. Particularly will this be the case if also there is considerable extent of traverse. There will also be a tendency for the leather to wear most at the points where the traverse changes. The kind of uniform extent of traverse given to the guide bar by the simple cam and crank traverse motions is exhibited at **A** in Fig. 61. A carder friend of the author's, in the Ashton district, has had a crank arrangement of his own device long working with the most satisfactory results, and there are many such examples of individual arrangement.

VARIABLE TRAVERSE MOTIONS.

The chief thing about roller traverse motions that has concerned practical men during the last few years has been

the invention and application of variable traverse motions. There are a number of these traverse motions in the market at present. In every case the principle is as follows:—

After the rovings have been moved along the roller for the first time, the next reciprocal movement of the guide bar is made to take place over a slightly different length of the roller, and this variable sweep is repeated for a good number of times, finally returning to the original movement. As previously mentioned, the objects sought are to have less wear in the leather, and, consequently, better work. In one well-known type, the first traverse only extends slightly on either side of the centre of the boss of the roller. Then each succeeding traverse increases in extent until the maximum is reached, when a gradual reduction takes place back again to the original short sweep. The kind of variable motion imparted to the guide bar by the above type of traverse motions is shown at **B** in diagram 61. Another type of variable traverse motion gives a different kind of motion altogether to the guide bar. This is shown at **C** in Fig. 61. Here it is seen that the extent or sweep of the traverse is uniform, but that it is small, and takes place over a continually varying portion of the boss of the roller within certain limits.

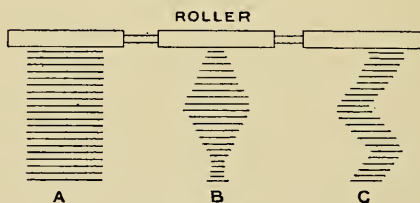


FIG. 61.

Variable traverse motions which give the kind of traverse shown at **B** have been patented by Messrs. Paley,

of Preston; Cook & Harrison, of West Gorton, and others. A motion to give the diagram at **C** is made by Mr. Morris, of Ashton-under-Lyne. The number of variations can be increased or diminished by altering the number of teeth in the wheels. In all these variable motions two eccentrics are employed instead of only one, as with all the simple cam motions. The function of the second eccentric is to continually vary either the relative position of first eccentric, or at any rate the sweep of the guide bar and rovings. With reference to the diagram at **B** it will be noticed that in every case the roving travels over a central position, and this, in the author's opinion, is a defect, as it tends to wear the leather most at that point.

In his opinion a good arrangement of the simple cam or eccentric style, with an effective provision for readily varying the extent of traverse, and for causing the rovings to go more to or less to either end of the bosses, as the case may be, will take a lot of beating, all things considered. There is no doubt that the variable motions are more complicated than the older arrangements, and in several cases within the writer's knowledge the advantage gained by their application has not been very apparent.

ROLLER COVERING.

It is scarcely necessary to say more than a word or two on this important subject at this point. There seems to be a growing tendency to have this work for Lancashire mills done outside, as there are several small firms who now attend solely to this kind of work. The functions that have to be performed in covering rollers are as given below:—

(1) All roller skins vary more or less in thickness, and they should be carefully assorted. In some cases this work is now aided by having a machine for grinding the skins on the rough side down to a uniform thickness.

(2) The leathers have to be cut to the correct size. First they are generally cut in strips of the required width for the bosses of the rollers, plus a little for ending. Then these strips are cut up into rectangular pieces sufficient to wrap round one boss. In cutting them up thus the cut edges are bevelled, so that when they are overlapped in making the piecing the joint shall be smooth, and only of the same thickness as the rest of the leather. In cutting them up a skilful roller-coverer will alter the guage very slightly at times, so as to compensate for variations in the thickness and pliability of the leather. When the piecings are made before drawing on the boss, they should stand crushing up in the hand and considerable bending and pulling at the piecings without the latter giving way at all. A splicing machine is commonly used to aid this cutting-up of the leathers.

(3) The operation which succeeds cutting-up is making the piecings by carefully cementing the bevelled edges together, and strengthening the piecing by putting the leather under a small screw press, or, better still, a small lever press, somewhat after the style of the Stanhope levers.

(4) DRAWING ON.—To draw the cots of leather on the bosses, a small drawing-on machine is used, such as shown in the author's treatise on "Self-acting Mules," where also will be found views of most machines used in roller covering.

(5) Afterwards the rollers have to be placed in an ending machine, and the rollers being revolved at a rapid rate, the ends of the leathers are burnt off by holding against them an ending stick, or in some cases some fibrous material such as thrums.

(6) CALENDERING. — The drawing-on and ending machines and the presses are indispensable, even for small mills. More recently a rolling machine has been extensively adopted, particularly in larger mills. In this

machine the rollers are calendered by being rolled over a heated surface. In some mills this rolling, or smoothening, has to be done by hand, or else left undone.

(7) TRUEING UP.—This is still another process which is adopted in some mills, in which the rollers are trued up by being subjected to the action of a revolving disc covered with fine glass paper.

In these days of severe competition buyers will sometimes purchase cheaper skins in order to save a little of something. They may pay say 2s. per skin, instead of 2s. 4d., and so on. Too much caution cannot be exercised in trying this cheaper leather. There is scarcely anything about the mill where inferior material will assert itself more strongly than bad leather. The immediate effects of using it are bad spinning, bad yarn, and rollers requiring to be recovered in much less time than should be the case.

Red Persian skins are often used for Egyptian and the finer qualities of cotton, and brown Welsh sheep-skins for the common run of yarns, or “garden numbers.” The Persian skins are often of a thinner nature than the Welsh.

CHAPTER X.

DEFECTIVE ROVING BOBBINS.

TESTS OF BOBBINS, Etc.

Under the above heading, and commencing with the issue of September 14th, 1895, the author contributed a series of articles to the *Textile Recorder* which are partially reproduced here in obedience to a request preferred to him by several persons interested in card room practice. A good proportion of the articles are omitted here, simply because they have been reproduced in other parts of this book, and care has been exercised to prevent duplication.

The subject we are intending to discuss is a very interesting and practical one to a large number of persons engaged in spinning cotton, whether into medium, fine, or coarse numbers, and whether on ring-frames or mules. The frame tenters and overlookers are to a large extent responsible for the quality of the work which is sent into the spinning room, although it sometimes occurs that they are blamed and made to suffer for defects arising in consequence of the use of bad cotton or machinery. If bad or even indifferent bobbins are produced by them they are likely to receive complaints and suffer loss. They are therefore largely concerned in this subject. On the other hand the spinners who use the bobbins coming from the card room have their work and anxiety largely added to if the roving bobbins are bad. Rovings which are defective

to any large extent will not be tolerated for long in these days of severe competition, long mules, and quick speeds. In addition to the largely increased amount of work laid upon the spinner, there is often an attendant loss of wages. Not long since the writer had a somewhat intimate connection with a case in which a claim for a considerable amount of wages was made by the mule spinners, owing to defects in the bobbins caused by the use of a poor quality of cotton. Such cases are by no means of rare occurrence. If defects arising out of bad shaping of the bobbins cannot be eliminated, the frames ought to be pulled down and replaced by new ones. Bad bobbins, however, can be managed with better than bad cops, which, when spun on the mule, have very frequently to be placed on the market for sale, and therefore must perforce be of a tolerably good shape, and fairly free from other defects, while the bobbins are almost invariably worked up upon the premises where they have been made.

“ THICK ” OR “ SINGLE ” ROVING.

An evil which is frequently present in roving bobbins to a greater or less extent, is the existence of “ thick ” or “ single ” places. By “ thick ” is meant a portion of roving which is much thicker than the standard, and which is generally caused by the entanglement or addition of an extra end either on the roving or intermediate frame. “ Single ” means the converse of this, being usually caused by the passage of one end only through the drawing rollers, instead of two. “ Thick ” and “ single ” are well-known Technical terms. These faults are only to be found where the roving is doubled for the purpose of eventually securing an even thread or yarn, two ends being put together at the back of the frame. It results, however, often in the production of “ thick ” and “ single ” roving, which is quite unworkable. Occasionally careless tenters

will allow a considerable amount of roving which is thus defective to pass forward, but this is certainly not as general a practice as it was 10 or 15 years ago, when spinners often had their window-bottoms full of bad bobbins in the course of a week. There are now a greater number of efficient tenters than formerly, and the margin of profit is so small that a spinning mill might as well close if any great quantity of bad rovings were made. Frame tenters, like other cotton mill operatives, have now to be much more careful than formerly.

The existence of "thick" or "single" rovings should never be allowed, because it is very apparent that any careful tenter, with fair play, can keep it out. The spinner, when it is present to any extent, is bound to remedy it, because roving of this character will not spin for long without breaking. It must be clearly understood that "thick" or "single" is not roving which cannot be detected except by careful wrapping and testing, or by the unevenness of the cloth woven from it, because these defects are very prominent and easily detected. As will be obvious, there are several variations in the kind of defective roving of this class, and an experienced man is often required to determine the causes of the evils. These are numerous, and it will repay the time spent to give them careful consideration. "Thick" roving may be produced at the front of the frame, by reason of the breakage of one of the ends and allowing it to be wound on the bobbins. If the tenter does not immediately notice the breakage, the broken end continues to pass, and after a certain length has been delivered the air currents caused by the revolution of the flyers, or some other cause, will entangle the broken roving with one of the adjoining rovings. Thus the latter, instead of containing portions of two back bobbins, will contain portions of four, the whole being twisted together and wound on the bobbin as "thick." The roving thus produced will obviously be twice the proper thickness. It

may happen, of course, that the broken end forms a roller lap. On the roller it may divide, one part flying loose, and the other part going on its own bobbin and making "single," or passing upon another bobbin.

If observations be made at the back of a frame it will sometimes be noticed that one of the ends which is being drawn from the creel will get out of the proper guide eye in the traverse rod, and become entangled with an adjoining end, so as to pass through the drawing rollers with it. In this and other similar ways thick roving is also produced, but there are only three ends twisted together, and not four as in the previous instance. There is, however, a further evil which arises from this cause. The adjoining bobbin, instead of having as it should have two ends in the roving, has really only one, because of the removal of one of the ends and its union with its neighbours. In other words, "single" is produced so that adjoining roving bobbins produce rovings which are in one case only half the proper thickness, and in the other case $1\frac{1}{2}$ times the proper thickness. It often happens, however, that the "single" end in passing from the rollers to the bobbin will break, owing to its comparative lack of cohesion. When it breaks it will probably pass on to an adjoining bobbin, and also make thick roving. These two varieties are of the same degree, although one of the extra attachments is made before, and the other after passing through the rollers.

"Single" roving is frequently made in small portions as follows: During creeling time at the back a tenter will have a large number of bobbins coming bare at once, while at the same time she may be busy doffing on the other frame, an operation which may last about 14 minutes, or doing something equally important and essential. She, therefore, allows some of the bobbins to become quite empty before replacing them with full ones. It results that for a certain length of time "single," instead of double ends, are passing through the rollers and being

wound on the bobbins at the front of the frame. This often occurs, and when the single is allowed to go on in very small portions, it is sometimes worse than if present in larger quantities. In the latter case it is almost sure to be detected and taken out at one stage or another, while the lesser defective portions frequently pass forward into the yarn and engender serious complaint on the part of the consumer. To prevent such an evil it is sometimes deemed advisable to arrange that the tenters shall creel one bobbin and miss the next one; or, in other words, to have one bobbin full while the next to it is only half-full. This compels the tenter to creel at two different times instead of all at once. She can, thereby, get through it more quickly and calmly, although her times of creeling are twice as numerous. The self-actor minders and piecers certainly suffer when such bad work, as above suggested, is allowed to pass forward. They are somewhat similarly situated to the weavers who always say "That they have to make good everybody's bad work." Up to the present the defects under notice have been dealt with only so far as they are caused at the roving frame. They may, however, originate at the intermediate frame. Of course it may be said also that they are only a particular development of the general defect of unevenness. But they are so pronounced in character that they require specific recognition. It may be said also that it is not necessary to search for their origin further back than the intermediate frame, as if they originated before that point they would be more properly designated as uneven rovings.

At the intermediate frame an end may break at the front, and becoming entangled with an adjoining end, pass therewith upon the same bobbin. This, of course, if carried through into the bobbins for the creel of the spinning machine, would give a certain length of thick roving. Again: two ends go up together from the creel of the intermediate frame. Let a third end, as often actually

occurs, pass through the rollers along with the pair of ends which should legitimately go together. Here we have a variety of "thick" roving produced which is different from any before mentioned. In some respects it is the very worst kind that can be made. The defect is of such slight proportions, as compared with any before mentioned, that it will frequently pass through the hands, not only of the roving frame tenter, but also through those of the spinner himself, simply because it will spin away for a long time without breaking. The writer has often been puzzled with this defect, and has frequently seen piecers and spinners perplexed with it. Thus a spinner will have an end that keeps continually breaking, and he is at a loss to account for the breakage. He will examine the cop to see if there is anything wrong with it, and finding it not altogether to his liking, he will oil the spindle footstep and bolster well, or pull off the "rib" and give the spindle a good shaking, or put a fresh spindle band on. The end after all this appears to stop up a little better, but in a short time it is perceived that there is no real improvement. He then picks and oils the rollers well and tries again, but without avail. He has previously examined his bobbin, but although it seems somewhat hard he is not at all sure that the roving is too thick. He is now reluctantly compelled, however, to take the bobbin out. When a fresh bobbin is put in the end keeps up all right, and a good cop is made. Such a procedure often takes place when from some cause an exceedingly thick sliver has gone up behind the slubbing frame, or two ends have been wound on together for a very short time at the front of the slubber. Thick roving, which has its origin at these places, is even worse to detect and localise than in the last mentioned, or perhaps any other case, because it will spin into yarn, although it will be a little too coarse. Here may be seen the vast importance of having these points carefully watched at the slubbing and intermediate frames.

There is no doubt whatever that many carders and frame overlookers are much more careless about such defects at the slubber than at the roving frame. The reason is not far to seek. Defects made at the roving frame at once leave their jurisdiction and pass forward under fresh superintendence, and as a result there will be probably strong complaints in a short time. On the other hand it almost invariably happens that the slubbing, intermediate, and roving frames are under the same overlooker, and if the intermediate tenter complains of the work from the slubber, it is very likely that he will not attach the same importance to her complaints, as he would to those of the mule overlooker, respecting the roving frame bobbins.

The same arrangement holds good for single or thin roving, which, if caused by a very thin sliver fed to the slubber, or if sometimes made at the intermediate frame, ought to be most guarded against because of the difficulty of detection when it gets spun into yarn. As regards single made at the intermediate frame through the tenter allowing a bobbin to become empty, or from any other cause, this portion of single will wind off the bobbin at the roving frame and pass through the rollers with a good bobbin, and a portion of roving will be produced that will be three-quarters the proper thickness for the mule creel, while "single" originating at the roving frame would give probably half the proper thickness of yarn.

To glance briefly at the various kinds of "thick" roving which have been alluded to, we have, first, that made at the roving frame which is twice as thick as it should be, and containing portions from eight intermediate back bobbins. The comparative thickness is shown in Fig. 62, in which **A** represents a roving of the proper diameter, and **B** represents the thick variety under notice. **A** is composed of the four parts shown, while **B** contains eight parts as shown.

C represents the variety which is, perhaps, more prevalent than any other, because of the different places at which it can be made, viz., at the front or at the back of the roving frame, and at the front of the intermediate frame. It contains portions from six intermediate back bobbins. **D** represents the variety made by allowing the three ends to go together at the back of the intermediate frame, and it contains portions from five intermediate back bobbins, when it leaves the roving frame.

Two or three practical methods of tracing these evils to their source in order to take the proper steps to prevent their recurrence may be indicated. When either thick or single roving is made at the roving frame, and is very

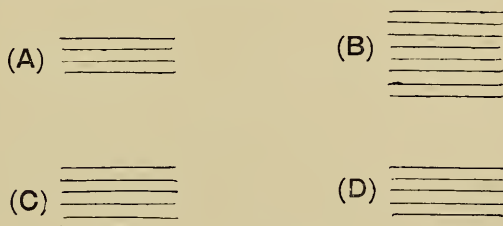


FIG. 62.

bad, it can usually be located at a glance. The thick roving, for instance, made by having 8 ends of intermediate roving together, instead of 4, is so coarse that it will not spin at all, and the twists are defined nearly as clearly as on an ordinary spindle band. The defective roving containing 6 ends of intermediate roving is more difficult to trace, owing to the fact that it can be produced at several different points. If made at the front of the roving frame there will probably be less of it than if made at an earlier stage, because of the attenuation of the roving. A piece one inch long at the back of the roving frame will be made about six inches long on the roving frame front

bobbin ; and the defective roving, containing 5 ends of intermediate, will from an inch at the back of intermediate become probably something like 24 inches at the roving, frame, the length varying the draft. In addition, the latter will make a more naturally built bobbin than the others. Exactly in the same way the defective roving originating at the slubber will make a still greater length at the roving frame bobbin and a more naturally shaped bobbin than the others.

One of the most satisfactory ways of tracing these often recurring portions of thick roving to their original source is to wrap the bobbins, and make a calculation to show how far they differ from the proper weight. Take, for instance, the case of $4\frac{1}{2}$ hank roving to be used for 36's yarn. Sixty yards of this roving should weigh 4dwt. 15gr. Suppose we wrap and weigh 60 yards from a bobbin which we know is too thick, and find it to weigh about 5dwt. 19gr. This is strong presumptive evidence that the evil has originated at the back of the intermediate frame by three ends going up together instead of two, which would give a front intermediate bobbin, the roving on which would be $1\frac{1}{2}$ times the proper thickness. This defective bobbin being put up with a bobbin of correct weight at the back of the jack frame would give a roving $\frac{1}{3}$ th too heavy. Subtract $\frac{1}{3}$ th of 5dwt. 19gr. from that full amount. Or, instead, take $\frac{4}{5}$ ths of it thus—

$$\frac{139 \times 4}{5} = 111\text{gr.} = 4\text{dwt. } 15.2\text{gr.}$$

As this 111gr. is correct for $4\frac{1}{2}$ -hank roving, we have fairly convincing proof as to the origin of this variety of "thick" roving.

Suppose, again, that 60yds. of the rove wrap 122gr.

This is $\frac{1}{16}$ th part added to the correct weight for 60yds. of $4\frac{1}{2}$ hank roving. The writer would take this as strong presumptive evidence that the evil originated somewhere

about the slubbing frame, and would turn his attention there in the hope of finding the cause and remedy the defect.

With regard to variations which are much finer than the last-named one, it is very probable that they originate in some of the earlier processes.

UNEVEN ROVING.

Although the defects of "thick" and "single" roving would be described by the general term of "uneven" roving, it has been deemed advisable to define them specifically and give them extended treatment. A few remarks may now be offered upon the less evident but not less prevalent defects which are formed as "uneven" roving. It is one of the most difficult things in connection with cotton spinning to get an even and regular yarn week after week and month after month. Indeed, there is no doubt that many employers and managers have more trouble from uneven yarn than from anything else, and but for the existence of the drawing frame the difficulties would be much greater. There is an enormous difference as a rule in the regularity of the sliver when it leaves the last head of drawing and when it leaves the carding engine, the advantage being with the drawing frame sliver. There are many cases which tend to make uneven roving to a greater or less extent. Some practical illustrations will be given. Take a case in point. At one time since the writer had to complain to the carder that his roving was coming up too heavy. They were not more irregular than usual, but being heavy the spinning overlooker had to put smaller change pinions upon the mules. This was repeated once or twice until the overlooker was short of change pinions to follow the roving. Hence the complaint to the carder. Investigation showed that the carder had purposely kept the roving rather heavier than he

should in order to get ahead with his roving frame bobbins as he had got a little behind. This is a very common and simple way of keeping one machine up with another when the speeds cannot be altered. In the case under discussion, the mule overlooker was compelled to diminish the speed of his back roller by putting a small change pinion on, and the mules in consequence took less length but the same weight in roving, owing to the latter being thicker. The carder immediately reduced his roving to the correct weight; but the change caused uneven yarn for several weeks, as the mules were spinning as high as 80's from a double hank roving, and the bobbins lasted over three weeks. Besides all this, there were many heavy bobbins on the creel, so that it was nearly six weeks before the heavy bobbins were worked off. In the meantime the bobbins were working in every fashion. In some cases two light bobbins were together; in others two heavy bobbins; and in others a heavy bobbin was working with a light one. This latter method, of course, was the best thing to do as far as practicable; but when short of bobbins it is only possible to do the best under the circumstances. This apparently simple alteration caused a good deal of trouble, owing to the irregularity of the yarn thus produced.

Take another instance. The cotton used was suddenly found to be losing a great deal in working, and, consequently, before the carder had comprehended this fact, the bobbins were leaving the cardroom rather light, the yarn also wrapping light. The mule overlooker had, in consequence to put larger pinions on. Simultaneously the carder was putting larger change pinions upon the frames, and carding a little heavier to allow for the increased loss of cotton. The natural result of this combined altering to larger change pinions, both in cardroom and spinning room, was that the yarn became all at once as much too heavy as it was previously too light, and it was weeks before things got properly settled down to their normal

standard. It will readily be understood that a good deal of unpleasantness resulted to all parties concerned.

The fact that some lots of cotton lose more than others is a matter which requires much vigilance to ensure the best results. It is always likely to crop up and to take one more or less by surprise. The writer has noticed that when some lots of cotton have been in work, the roller beams, flyers, and other parts of the machine have been covered with fluff almost immediately. He has known warps from the beam warping machine to weigh 200lbs. instead of 208lbs., while the winders were almost covered with fly and fluff. The yarn which was spun from American cotton and single roving was at the same time the correct count. Egyptian cotton, from its known possession of a very large proportion of short undeveloped fibres, particularly in certain seasons, is often worse than American. Indeed, it may safely be said that there is no class of cotton that is more difficult to deal with than a bad class of Egyptian or Sea Island cotton. At the same time it often happens that an extra good quality of yarn is required from it. The causes of uneven roving, just dealt with, are general and far reaching, and affect a large quantity of material at one time. There are many purely local circumstances which cause defects in the bobbins. For example, the writer at one time had to complain strongly about the rovings that were being made by a certain frame, inasmuch as they seemed cut and thin at places. Upon an examination of the frame it was found that the small middle roller wheel was very loose, which caused the middle roller to revolve somewhat irregularly. Small mishaps in connection with draft rollers often cause cut roving. The middle roller pinion or the back roller wheel may rub against the front roller and thus create a jerky motion in these rollers. One or other of the draft wheels may be loose, or they may have several teeth broken out of them, with disastrous effects to the

roving. A common enough cause of uneven roving is the fluting of the leather coverings of the top rollers, or the bad setting of the rollers. The writer once noticed that some rovings were coming up quite cloudy and uneven, looking and giving a yarn full of thick and thin places. Upon enquiry it appeared that the carder had opened the frame rollers very considerably. It had been necessary to do this to some extent, inasmuch as the rollers were "spewing;" that is they were delivering portions of roving in an undrawn and hard state, spoiling the rollers and giving the tenter much work. In attempting to remedy this fault the other extreme had been resorted to, and the rollers had been opened too much. It is one of the peculiarities of Egyptian cotton and double roving, both at the frames and the mule, where a large roller draft is necessary, that the rollers have to be very carefully adjusted. If they are set too far apart, cloudy roving and yarn occurs, and the rovings on the mule have a trick of wrapping round the middle iron roller in a manner that is disconcerting in the highest degree to a person who has been only used to American cotton and single roving. This is always worse when the cotton is worse in quality. The best remedy for it is to close the rollers, and then we are immediately face to face with "spewing" and with spoiled leather rollers. It is a good thing at such times to rub the middle iron rollers well with "pumice stone." This material is cheap, and being rubbed well upon the rollers, it takes rough places off them, but they should be afterwards well rubbed with whitening. When a large proportion of short fibre is present in the cotton, it is well known that the sliver is apt to issue from the rollers in a body, *i.e.*, an extra quantity will issue at intervals, leaving immediately afterwards a thin place. The fact that the presence of long and short fibres produce weak and uneven roving and yarn is too well recognised to need anything more than mere mention.

The defects treated upon hitherto in this series of articles have been such that no inventive ability as applied to the construction of the various machines, and no skill and accuracy as applied to their regulation, setting out, and mechanical working could remedy. Before passing on to deal particularly with the arrangement and practical working of bobbin and fly frames, etc., there is one more external cause of what may be termed defective rovings that may be noticed.

The writer has frequently been brought to mules which were spinning the greater part of the cops properly, while some of them were quite soft and unworkable. Clearly the soft cops originated from the roving bobbins. After investigation and after wrapping the bobbins it was fully established that they had been mixed. There may be, and often are, five-hank and six-hank bobbins, respectively, made on adjoining frames. In one specified instance the bobbin carrier had evidently taken some of the six-hank bobbins to the mule using five-hank. Bobbin carriers, particularly in mills where there is inadequate provision of hoists and slips for conveying the bobbins, are notably strong in the arm and weak in the head. The writer has often been convinced that employers would profit in many cases by paying a little more wages to these men, who are generally the hardest worked and proportionately worst paid of any workers in a cotton mill. In addition, they seem to have as many masters as there are spinners, tenters, and overlookers. Better wages would often secure more profitable service and care as regards the bobbins.

Coming now to the practical working of the frames themselves, it may be said that there is a tremendous amount of roving rendered defective by inaccurate adjustment of the various parts in connection with the winding of the roving upon the bobbins on the one hand, and those in connection with the shaping of the bobbins on the other hand.

In regard to the winding, it is generally agreed that the self-acting mule and the comber are the two most intricate machines concerned in the spinning of cotton. This is doubtless true in so far as they contain more parts to be understood and adjusted than any of the others. The writer, however, is of opinion that the absolutely accurate adjustment of the parts, more or less connected with the winding of the attenuated roving upon the bobbins of speed frames, presents greater difficulties than any in connection with the other machines. This is due to the nature of the material that has to be wound, a factor which, as a rule, is by no means sufficiently appreciated by practical men.

It would be quite impossible to deal as roughly with roving as with yarn, and it would never stand the strain of backing off, or of the weight of the faller wires in winding that yarn will. As a matter of fact, yarn during winding is constantly subjected to tension, which is either too much or too little, with scarcely any injury. Roving may have, say, $2\frac{1}{4}$ turns of twist per inch put into it, whilst the yarn spun from it will have about 20 turns per inch.

Again: The different change wheels are more closely related to, and connected with, each other on these frames than on any other frames; at any rate, so far as the winding is concerned. The twist wheel, for instance, is connected with all the six or seven different change wheels on a speed frame. A larger twist wheel would speed up all the other change wheels, and affect everything except the speed of spindles and counts of roving. It would increase the delivery of roving, the rate of winding, and the speed of the lifter. The writer has often had to contend with roving that has been irregularly drawn, and the utmost attention has been bestowed upon the rollers as regards putting new wheels on, cleaning, altering weights and middle roller drafts, &c. All the time the evil has arisen in the parts concerned in the winding by having

something worn, or badly set, or a wrong wheel on, the worst offender being the ratchet wheel.

On the part of many carders and frame overlookers there is, without doubt, much difference of opinion and a great deal of imperfect comprehension as to the correct size of ratchet wheel to put on. Take one or two cases in point. Two or three years ago a carder of the writer's acquaintance undertook the charge of the blowing room, card room, and frame room of a small spinning mill, in a town where he had not previously worked. Shortly after, he boasted that on some of the frames he had actually taken nine teeth off the ratchet wheel. Quite recently there has again been a change of carders at this mill, and the new carder now says he has had to alter some of the ratchet wheels considerably on the same frames. It is quite certain one or other, or, what is not at all improbable, all the three carders have been more or less wrong, with disastrous results to the roving,

Again, an excellent head carder of the writer's acquaintance, who has charge of a considerable number of spindles, and has been a carder for nearly thirty years, some time ago mentioned another instance which had recently come within his own experience. Some intermediate frames that had formerly been under his charge, and had done well, had been relegated to the charge of another carder. During that period the hank of intermediate had been altered, and fresh wheels put on to meet the case. The frames after that did not make as good material, and, moreover, the tenter had to doff the bobbins before they were full, because all the length of the cone drums had been traversed by the belt. After several experiments, a much larger ratchet wheel was put on, and various minor alterations were made, with the most satisfactory results. The ratchet wheel, being previously too small, had allowed the cone belt to travel too much at each change of the lifter traverse, with the result that the strap was moved along

the whole length of the cones more rapidly than was required to meet the increase in diameter to the bobbins. Having given two illustrations of actual experience to show the vague ideas prevalent amongst some practical men in regard to the ratchet wheel, something can now be said in the way of an attempt to explain the defects, or otherwise, of the procedure.

There is only one diameter of the driven cone which can be correctly allocated to the corresponding diameter of the bobbin. If, for instance, there are 40 layers of roving on the bobbin, then there are, or should be, 40 diameters of the bottom cone to correspond therewith. It would not do to have, say, the cone belt on the 30th diameter of bottom cone for the 40th layer of roving, nor, on the other hand, would it do to have the 40th diameter of cone to the 30th diameter of bobbin. To secure the best results in winding, the 30th diameter of cone should have the cone belt on it for the corresponding layer, and so on, from the first to the last layer in the bobbin diameter. The writer's experience and observation lead him to think that such accurate results are in many cases unattained. Many practical men, to the writer's knowledge, when making a change of roving, will be very particular about adjusting the twists correctly and the counts of roving, but will treat the ratchet wheel in quite a careless and indifferent manner. If a ratchet wheel is put on which varies considerably from the correct size, it cannot be compensated for by any other change. If, for instance, the frame is started with too large a ratchet wheel, the winding may be absolutely right for the first few layers, but afterwards it will be too tight, and become more and more so as the bobbins fill. The exact duty of the ratchet wheel in the practical working of a fly frame is somewhat complex, much more so than on the mule or ring frame. On the latter machines it simply regulates the diameter of the cops, and the winding is ad-

justed thereto by other means. On the fly frame it has a great deal to do with making the bobbins harder or softer, as the case may be. It would be a good thing if in the economy of a fly frame there were an equivalent to the counter faller weights of the mule. On the latter machine it is quite possible, and, indeed, a common thing to have the threads of yarn wound so slackly that the run-in of the carriage finishes with long snarls left in the yarn. This, in the case of a careless minder, may take place more or less all through the set of cops, and yet the cops, when finished, be quite hard, owing to the counter fallers being well weighted. Of course, it is not forgotten that we have the presser on the fly frame, which, in the effect produced by it, is analogous to the counter faller weights of a mule, and is undoubtedly a splendid little contrivance, giving us much harder and better wound bobbins than would be possible without it. All the same, the fact remains that the ratchet wheel exercises a considerable effect on the hardness of the bobbins. The writer, however, is of opinion that too much reliance is placed upon its hardening properties, and too little attention to its duty of keeping the cone belt on the correct positions of the cones all through the making of a set of bobbins.

It is sometimes the case that the diameter of the empty bobbin is varied for some purpose or other. It is a very common practice in such cases to ease the winding and the speed of the lifter by putting a less wheel on the end of the bottom cone, or making an equivalent change by some other wheel. This makes the winding and speed of lift correct during the first layer. In the writer's opinion, however, such a procedure is inaccurate. It destroys to a greater or less degree the fundamental principle of maintaining a certain diameter of cone to a certain diameter of bobbin, which has been laid down in a preceding paragraph. It appears clear that in such a case the more correct method is simply to start the cone belt a little up

the bottom cone by making the necessary slight adjustment of the cone strap-fork. This method would keep correct winding all through the set, whereas by the other method the winding might be correct for the first layer or so, but would afterwards vary somewhat. On the other hand it often happens that the cone belt-fork is set up the bottom cone wrongly, when there has been no change of the bobbin diameter or any other equivalent. This is absolutely wrong in principle. The thin end of the bottom cone should in such cases be reserved for the first layer of roving. The bottom cone is in its shape an absolute counterpart to the bobbin, inasmuch as the various increments of diameter of the latter, from the beginning of the set to the finish, determine the corresponding diameters of the cone. This important feature should never be lost sight of.

If the cone strap-fork be set to have the belt at its start too far up the bottom cone, then it is very probable that the frame tenter will, after running the frame some little time after doffing, wind the belt back somewhat in order to tighten the ends.

It is also quite common for frame tenters to do this when the ends become slack from other causes, such as, for instance, a slack cone belt. This practice, though often very prevalent, and sometimes the lesser of two evils, ought to be avoided as much as possible. A tenter, at times, will either let off to slacken the ends, or wind back to tighten them, but more often she will do the latter, in order to get harder bobbins. In any case, a good carder will endeavour to prevent such a procedure as much as possible by keeping the cone belt at a proper tension and on a proper diameter of the cone drums.

As in many other cases of manual operation a tenter will often overdo the adjustments of the belt. If the ends are too slack, she may, after a time, wind back the cone belt, and wind it too much. Thus the ends will be con

tinually either too slack or too tight. Much depends upon the experience and skill of the tenter.

It happens occasionally that something in connection with the mechanism appertaining to the winding becomes loose or worn or broken. The winding being thereby affected, the overlooker will endeavour to make up for it by changing the size of ratchet wheel instead of devoting a sufficient amount of time to the discovery and remedying of the defective part. This is a very bad practice.

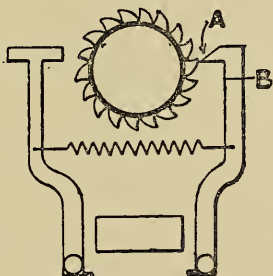


FIG 63.

Take an example. The right hand catch in the sketch may get worn at **A**. This causes the catch to have an insufficient bite on the ratchet wheel teeth, and consequently when this catch is coming into action at the change of the lift, a tooth or so of the ratchet wheel may slip and allow the cone belt to move too far up the bottom cone, thus causing slack winding. In such a case the best plan generally will be to file the catch down at **B** somewhat in order to give it a better grip on the teeth of the ratchet wheel. Of course the evil will have to be discovered and traced to its source before the remedy can be applied. A similar effect, but in a less degree, occasionally results from the bits of dirt getting clogged in the ratchet wheel teeth.

RUNNING OFF.

To the matter already given in this treatise may be added the following on running off at the ends of the bobbins:—

LIFTER SHAFT PINIONS.

Occasionally, but very seldom, the small lifter shaft pinions will break. If they do, it is a somewhat lengthy and troublesome operation to replace them. Of course, if any of these wheels have broken teeth, it will re-act detrimentally upon the motion of the lifter, and therefore upon the shape of the bobbins. If the teeth are broken out at such portions of the wheels as should be in gear with the racks at the termination of the upward or downward lift, there will be a tendency to slattering of the roving.

On account of the shortening of the lift, however, it has been the writer's experience that often an ugly place in the build of the bobbin will be formed, other than running over or under.

We will take a case as an illustration.

The writer on one occasion noticed that some of the bobbins from a certain frame were being made with a bad place in them, something like that indicated at **A** in Fig. 64, although not to the same extent, as the drawing is exaggerated.

Upon investigating the matter, it was found that one of the small lifter shaft pinions was broken. The overlooker

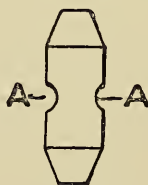


FIG. 64.

knew about it, but had not replaced it, for want of a wheel of the right sort. In such cases as these, it will on most occasions, be the better plan to throw the wheel out of gear when doffing, and work without it altogether until a renewal can be made. If the broken wheel be left on, the the lifter will work all right whilst on the good part of the wheel, but when the bad or broken part is reached, there will be a disagreeable movement on the part of the lifter which will have its effect on the bobbins in some such manner as indicated in Fig. 64 at **A**.

On the other hand, if the wheel be put out of gear altogether when starting a new set of bobbins, the lifter will settle to a very slightly altered position at that point, but will maintain it all through the set, and will not be detrimental to the bobbin. This procedure the writer has often seen put in practice. There is usually one lifter balance weight to every lifter shaft pinion, and it will be, probably, the better course to leave the weight on although the corresponding wheel is not being used.

VERTICAL LIFTER RACKS.

It has been remarked that the small lifter shaft pinions do not often break. This, however, is not because they are not subjected to undue strain. As a matter of fact, this is often put upon them from a variety of causes. On such occasions instead of the pinions, the vertical lifter racks, or the brackets connecting the latter to the lifter rail, will break. Either is preferable, because it is much less troublesome to replace these than the small pinions. This is an example of an excellent principle in practical mechanics, which is often utilised at different points in cotton mill machinery. It is a case of taking the lesser of two evils when it is impossible to avoid both of them. At various points in the different machines, particularly with regard to the changes, there is always a greater or

less liability to breakage in some of the parts. In such cases it is clearly the better plan to contrive that a bracket or other part which can readily be replaced, shall be made the weakest, so that it will break, in preference to parts which are difficult to get at.

It is not a difficult or long operation to replace the vertical racks, but considerable care should be exercised in fitting them accurately, or there is sure to be something wrong at one portion of the lift or another. Take a case in point.

A mechanic was employed to make a number of repairs in an intermediate frame. When the frame was started again it was found that for a few traverses of the lift after doffing, there was an erratic movement of the lifter, which resulted in the cotton being wound upon the top end of the bobbin. After the first few double lifts the material was wound upon the bobbins quite correctly. This made the source of the evil somewhat of a mystery for some time. After several sets of bobbins had been made without discovering the cause, the frame was stopped at the bottom of the lift, immediately after doffing. A close examination of all the parts was made, and, finally, it was found that two of the vertical racks had their lower extremities touching the floor. The fitter, in renewing them, evidently imagined that he was setting them with sufficient accuracy to allow of a clearance at all points of the set of bobbins. or else he had ignored the point altogether. After the first few layers had been deposited on the bobbins, of course the lift was automatically shortened, and a clearance was left between the racks and the floor, and winding proceeded correctly.

EVEN LAPS, ETC.

Upon the 21st March, 1896, the present writer delivered a lecture to the Managers' and Overlookers'

Society, of Ashton-under-Lyne, upon "Some of the Principles of Cotton Spinning." Amongst other questions put at the close of the lecture, one well-known member asked if the lecturer thought regularity of laps was a guarantee of regularity in rovings, and in the finished yarn. The answer given was to the effect that the lap being the foundation, or basis, of the system of producing a regular yarn, it was vastly important that laps of a uniform weight should be secured. At the same time, the lecturer did not think that because the laps weighed alike all the week round, this was a guarantee that regular yarn would be secured. The piano feed regulator, for instance, whilst materially assisting in giving laps of uniform weight, did not ensure that the lap should be one thickness all along its width. Again, the action of the carding engine, in having one inch of lap to be attenuated to about 2,000in., by the difference in circumferential speeds between the feed roller and cylinder, and this 2,000in. being again reduced to about 100in. by the comparatively slow surface speed of the doffer, and also the manner in which the doffer comb performed its work, and the action constantly taking place at other parts of the carding engine, were none of them calculated to maintain absolute uniformity in the resultant sliver. As a matter of fact, it was well known that the slivers from the carding engines in even the best regulated mills varied in uniformity of hank, at times to a considerable extent. Moreover, it was quite possible that carelessness in the subsequent processes could easily produce irregular rovings and yarns. With this view of the matter the members of the society seemed to coincide. The tone of the discussion all tended to indicate that the drawing frame was regarded as being the one machine above all others for laying the foundation of even rovings and yarn. Also there was a somewhat general impression that the variation in the weight of laps at most mills was greater than many of those immediately

concerned in producing the laps would admit, and that assertions to the effect that full laps only varied within the limits of 40zs. heavier or lighter than the average should generally be regarded with suspicion.

DISTANCE BETWEEN POINTS OF SUSPENSION OF ROVINGS, ETC.

The distance which obtains between the nip of the front rollers and top of the flyer exercises some influence over the character of the roving produced. Particularly is this the case when a very fine or otherwise weak hank roving has to be produced. Generally, it will be found that the bobbins in the front row are somewhat more spongy, and have a tendency to fill sooner, than the bobbins in the back row or those nearest the rollers. To illustrate this point, the writer knows of a firm where they had occasion to put a portion of their roving frames upon a very fine hank roving; in fact, closely approximating to a 40 hank. Some new frames, by a well-known firm of machinists, were first tried with the fine roving, but these frames could not by any means be got to successfully carry the roving. Afterwards some very old frames were tried, and the rovings produced by them gave every satisfaction. The only reason that could be discovered for the increased superiority of the old frames was that the spindles were nearer to the rollers, and in a lower plane relatively to the rollers, than in the case of the new frames. Because of the difference between the rovings from the front and back rows of spindles, many spinners of fine yarns formerly had bobbin and fly frames containing only one row of spindles. Practical experience has demonstrated, also, that when the tops of the spindles are placed higher up, or, again, further away in relation to the nip of the rollers, more twist is required in the rovings.

Closely related to the same idea is the distance of the nip of the back roller from the creel bobbin. Some

carders, who have to produce a very regular roving, attach such importance to this point that they will have all the guide rods over which the rovings have to pass carefully adjusted to be the same distance from the back roller on one frame as on another. This is done because it is considered that the extra drag on those rovings which have to be carried further is sufficient to exercise an influence upon the character of the roving produced. Such rovings will tend to be finer, and after going through the rollers, will only have the same amount of twist in, and an appreciable difference for the worse will be manifest. Probably a point of much greater importance is to take care that there should always be one system of setting the bobbins into the creels. The best system is to have always one full and one half bobbin running together. This will always tend to produce more regular roving and yarn than any other system of creeling, because it better meets any variation that may exist in the creel bobbins, and it also keeps the piecings of the creel bobbins from passing all into one lot of front bobbins. This system is professedly enforced in many mills, but the frame overlooker should always keep his eye on the tenters with regard to this matter, as it is one of those things in which tenters are apt to get careless, unless kept up to the mark by their superiors.

Another trick that tenters are often guilty of may be described as follows :—A portion of thick, or single roving, is allowed to pass on to a bobbin—say to the extent of four or five layers—before the tenter discovers it. She will then pull the defective layers off and piece up the broken end, and start the frame again. Because the bobbin is smaller in diameter than the rest, to which the winding has been adjusted, it will naturally wind slack. This difficulty she overcomes by passing the roving right from the flyer leg, through the eye of the presser, and upon the bobbin, without wrapping it round the presser finger twice or so as she ought to do. Often in such cases a

tenter will change a bobbin, and put on one that is slightly smaller, or larger in diameter than the rest, and then adjust the winding by simply wrapping the end round the presser finger to a greater or less degree, as the case may be, than it ought to be.

To show the extreme difficulty of tracing the causes of defective rovings at times, the following circumstances may be quoted :—A carder friend of the writer's had a slubbing spindle which shook about considerably, owing chiefly to the flyer being out of balance, and at the same time short collar bobbins being used. The result was a soft, pulpy bobbin from this slubbing spindle, owing to the extra strain put upon the cotton, and only the same amount of twist going into it as into the other bobbins. The carder was determined to trace the ultimate effect of this defective bobbin upon the finished yarn, and he placed it in the creel of the intermediate with a good bobbin. This action was repeated at the roving frame, and then the roving bobbin was placed in the creel of the mule. The precaution was taken of selecting a mule spindle on which the string was quite up to the average in tension. After all these processes had been passed through, the cop spun from the defective slubbing bobbin was decidedly of a softer build than the average cop spun at the same time from the same mule. Such defects as this are rendered more obvious when there is only a small amount of twist put into the slubbing and roving.

TWIST IN THE ROVING.

It is well enough known that the correct regulation of the twist is a most important duty of anyone concerned in the proper working of bobbin and fly frames. The common-sense and practical method of regulating this twist is to put as little as possible into the material, so long as it will stand the strain of the winding upon the bobbin at the

frame, and unwinding at the spinning machine, without stretching or breaking. As regards unwinding in the creel of the mule, the greatest difficulty is experienced with weak rovings when the cotton is nearly all pulled off the bobbins. At this time, many of the bobbins cannot be pulled round by the rovings, which are constantly breaking. This is a sign that more twist is required in the roving, although it sometimes results from the skewers or skewer steps being rough, or the roving being strained somehow. It has often occurred to the writer that the practice which some firms have of never disturbing their twist wheels for the same hank roving, no matter what is the quality of the roving, is not correct in principle. It certainly does appear that the better practice is to change the twist wheel a tooth or two less when the cotton is worse than the average, and a tooth or two higher when a better class of cotton is being used. This method, however, is open to the objection of having usually to alter the price per hank paid to the tender. Of course, if too much twist is put in the roving, it will be harder to draw out in the rollers of the spinning machine. Ordinarily, the twist in the roving cannot exercise much effect upon the quality of the yarn, as the roving twist is nearly all taken out in the mule rollers. For instance, with the usual rule for American cotton in 4 hank roving, we should put in

$$\sqrt{4} \times 1.2 = 2.4 \text{ turns per inch,}$$

and having 9 of a draft in the mule rollers, we should have only

$$2.4 \div 9 = .26$$

of a turn of twist per inch left in the roving. In addition, the drawing action of the rollers tends to destroy even this small portion of twist. Cases have been known, however, where an excessive amount of twist has been put in the roving, and it has affected the quality of the yarn. For instance, in one case some low counts of yarn were required to be spun at a firm where the hank roving

was much too high for this yarn. In order to give the stuff a fair trial, in one case the thick yarn was spun from intermediate bobbins, without passing through the roving frame at all. In another case for the same yarn, two roving frame bobbins were put together through the rollers of the mule, in order to get the counts coarse enough. It was expected that the latter yarn would be much the better, but the result showed exactly the opposite. The yarn from the intermediate bobbins pulled 10lbs. better than the yarn from the roving bobbins, probably owing to the twist having to be taken out of the fine roving.

“ SINGLE ” AT THE CARD.

Readers of this series of articles will long since have noticed that, under the title of “ Defective Roving Bobbins,” we are including any points which we think affect the quality of the roving itself, or the build of the bobbins made at any of the bobbin and fly frames. Any circumstances, therefore, which cause the cotton to arrive at these machines in an improper condition come within the scope of our title. It has been also the great aim of the writer to avoid, as far as possible, giving an academic tone to the articles, and to make them as thoroughly practical as possible. One point we have not hitherto referred to is the deterioration of the slubbings, or rovings, by the “ single ” at the carding engine. By “ single,” it will be understood that we do not mean unevenness, due to the laps being somewhat too light or too heavy, or one portion of the same being heavier than another, but we mean the passing forward of a portion only of the width or thickness of a lap, instead of the proper amount. This evil is largely caused by lap licking, which seems to be ever present with us to a greater or less extent. We may just remind our readers that some of the more common causes of lap licking are—having too much waste or soft cotton in the mixing; imperfections in the draft; having a lap which is too thin and weak; improperly weighted

calender rollers; and other circumstances, including—as some people think—having cages of equal size, instead of the top cage being larger in diameter than the bottom cage. At one time a manager, well known to the writer, had a wooden stage pulled down upon which the mixings of cotton had been made for years. Whatever be the reason, the fact remains that the laps ever since have shown a much greater tendency to lick than previously. It is almost unnecessary to explain here that by lap licking is meant the adhesion of one layer of a lap to another when unrolling at the back of the card. This, of course, is followed by a portion of lap going forward, which is much too thin, and is termed “single.” If only 12in. of this thin lap goes through the card, with a draft of 100, the 12in. of lap becomes 1,200 inches of thin silver. Whatever may be the extent of the deficiency in weight which remains after passing through the draw frames, with a draft of 4·5 in the slubbing frame, we get 5,400 inches of more or less light material put on the slubbing bobbins. The writer, however, is strongly of opinion that practical men attach too much importance to this point, under the impression that the discrepancy in weight is much greater than is really the case. To illustrate the immense power of the drawing frames in reducing such irregularities, we will assume that we have six pieces of sliver from the card, each two yards in length, and the correct weight for two yards is 96 grains, which would be equal to ·17 hank carding. Five of the slivers are the correct weight, but one of them only weighs 50 grains, which is practically only half the correct weight. We double these slivers together at the first head, and obtain a resultant sliver, as follows :—

$$\frac{96 \times 5 + 50}{6} = 88\cdot3.$$

We now double this sliver again, with five correct slivers at the second head, and obtain—

$$\frac{96 \times 5 + 88 \cdot 3}{6} = 94 \cdot 71$$

The operation being repeated at the third head we obtain—

$$\frac{96 \times 5 + 94 \cdot 71}{6} = 95 \cdot 78 \text{ grains.}$$

It is probable that much of the defective slubbing attributed to “single” at the card has its origin at the drawing frames, owing to unbalanced spoons, &c. It must not be imagined that all the “single” issuing from the carding engine is caused by lap-licking. Often a great deal of “single” is caused by imperfections in the working of the scutchers, which are at times only remedied after much time and trouble. Take a case in point. The laps from a certain scutcher were continually coming up, with thin places here and there. Upon watching the machine, the blow-major could see the thin places being made, but for a long time could not discover the cause. Eventually it was found that the fork belonging to the cone drum belt had been rubbing on the driven, or convex cone, and had worn a hollow place on the cone. This at times so affected the belt as to cause a serious amount of slippage, and the feed roller was driven by jerks. If the cone belt is slack when the scutcher is started, the belt will sometimes slip and cause “single,” although in such cases the attendants sometimes hold the belt by hand on the fast speed owing to the cone belt, only working about the centre of the cones, the author is of opinion that uniform cones would work satisfactorily on a scutcher. “Catches” are pieces of stringy cotton and hard lumps, which get fast on the sides of the cages and on the cages themselves, and on the cage dust bars, and result in thin places in the lap. Numerous other circumstances may bring about a similar defect, but enough has been said to indicate one phase of the subject to our readers.

DEFECTS DUE TO THE DRAW-FRAME.

Reference has been made to defects in the slubbing having their origin in the drawing frames. It goes without saying that all working parts of these frames should be kept in good repair, and it may be remarked that there are few parts about a draw-frame which, by reason of the work they have to do, are liable to considerable wear and tear. In an ordinary spinning mill there is no machine of importance which requires as little expenditure on repairs as the draw-frame. There are, however, some details that are subject to deterioration in the course of time, and these may be briefly pointed out.

The iron rollers of a draw-frame revolve at a comparatively rapid rate, and are often of larger diameter than the iron rollers in any of the other machines. The necks of the rollers and the brass bits on the stands are therefore liable to wear, resulting in the iron rollers lying lower down than they should do. Also they are caused to bear on one side, instead of assuming a fresh position in exactly the same plane as before. This often causes the top rollers to press heavily against the dividing nebs, and the leather roller ends become dry sooner than they would otherwise do, causing a retardation of the top rollers and irregular drawing of the slivers. At proper intervals, therefore, the worn brasses should be renewed, and the iron rollers and roller stands made good in other respects. Great care must be taken to have the rollers to revolve freely and easily in their bearings.

The calender rollers run at a comparatively high rate of speed, and are very heavy, and liable to wear at their bearing points. The consequence is that less pressure is put on the sliver, and the latter is not drawn forward with sufficient regularity. The sliver is drawn forward sluggishly, and it sometimes happens that it licks up the dirt and fly from the front plate (at any rate in some old

frames), and the fly is thus drawn forward with the sliver. This is perhaps more particularly the case where there is no draft between the front drawing rollers and the calender rollers. The ends, or bearing surfaces of the calender rollers, may have cast-iron bushes put on them to compensate for the wear. On some frames the two calender rollers are level with each other, or in the same horizontal plane. In other cases one calender roller is placed slightly higher than the other, and rests upon the lower roller. A good method of testing whether the calender rollers are working efficiently is to put thin paper between them, and at different portions of their length. The paper must be held firmly by the rollers at each point, and when pulled it should have a tendency to tear before being released.

The fast pulley must be kept absolutely firm in its hold upon the front roller. The connections between the roller and the pulley are liable to work loose, and the practical defect resultant therefrom is a sudden shock in starting the frame, and a backlash which may injure the slivers. Draw-frames are more subject to frequent stopping and starting than any other machine in the mill. The spoons should be taken out and cleaned at frequent intervals, as they are liable to get blocked up with fly and dirt, and to act slowly, with the result that the ends of the broken slivers get through the back rollers before the machine knocks off. The same remark applies to the front trumpets. The reaching lever stud has a tendency to become worn, with the result that the lever loses some of its throw, and consequently the frame knocks off late, and waste is caused between the front roller and the calender roller.

The coiler foot plates must have their central pivots set in correct position, and should hold the can perfectly perpendicular, in order to ensure an orderly disposition of the coils of sliver in the cans. All the connections of the stop-motions ought to be placed in the best of working order. The top rollers should be kept efficiently covered

with good leather and flannel, and both top and bottom rollers carefully set at a distance apart to suit the length of the cotton fibre in use. All the saddles, wires, and hangers appertaining to the rollers must be in good working order. The top clearers should be kept well covered with flannel, and not allowed to wear down to the bare wood, as is occasionally the case. For the better classes of yarn from Sea Island and Egyptian cotton, it may be taken that one make or other of the patent revolving clearers ought to be used, in preference to the flat stationary clearers, so popular for lower numbers.

TENSION OF THE ROVINGS.

Previously some remarks have been made with reference to the twist in the rovings. Several ideas, however, on the same subject were held over, and will be now dealt with in connection with the subject of tension. James Hyde, in his "Science of Cotton Spinning," many years ago wrote:—"There is much difference of opinion with regard to the quantity of twist necessary to be put in roving. Some say as little as possible, provided there is sufficient to give it strength to unrove from the bobbins without straining. To this I decidedly disagree, for it is more subject to strain in winding on than by unroving from the bobbins." All the experience of the present writer, however, goes to prove that the rule with which Mr. Hyde disagreed is one of the best practical rules it is possible to give. Times without number he has experienced the greatest difficulty in getting the roving to pull off the bobbins in the mule creel when it has been wound upon the bobbins at the roving frame with little or no trouble. Particularly has this been the case when the bobbins in the mule creel have run until only a few laps remained on them. It must be remembered, in view of Mr. Hyde's statement, that on the roving frame special mechanism is applied for adjusting the winding to the delivery of roving from the rollers; and it is well

known that this winding mechanism is wonderfully perfect in its action upon the differential speed of the bobbins. Of course, it can be so badly regulated by wrong wheels, &c., that the roving is strained. Moreover it is not forgotten that present winding mechanism is probably better arranged than in Mr. Hyde's time.

However, regulation of the twist and regulation of the tension or winding are two different things, and when a carder is troubled with soft and strained rovings he should examine and calculate both the twist and the strain. It is a very easy matter, indeed, to count the revolutions of the spindle to one of the front roller, and to then perform the simple division calculation necessary for determining the exact amount of twist he is putting into each inch of roving that issues from the rollers. To determine, however, by calculation whether there be any draft or gain between the front roller and the bobbin involves a somewhat difficult problem. The following is a method that can be adopted in such a case:—Find the inches delivered per minute from the front roller, and also the inches wound on, say, the empty bobbin, per minute, from particulars ascertained as given below:—

Revolutions of main shaft or jack shaft per minute	...	350
Number of teeth in twist wheel	... ..	35
„ „ „ wheel on centre of top cone shaft	...	40
„ „ „ „ end „ „ „	...	40
„ „ „ „ front roller	... ..	120
Diameter of front roller in eighths of an inch	... ..	$\frac{9}{8}$

$$\frac{350 \times 35 \times 40 \times 9 \times 22}{40 \times 120 \times 8 \times 7} = 360.93 \text{ in.}$$

= length delivered from front roller per minute.

Revolutions of sun wheel per minute	... ..	18
Number of teeth in driving part of compound or socket wheel	... ..	50
Number of teeth in wheel on end of bobbin shaft	...	40
„ „ „ bevel wheels on „ „	...	50
„ „ „ small bobbin bevels	... ..	25

Diameter of empty bobbins in eighths of an inch ... $\frac{10}{8}$

$$\text{then } \frac{18 \times 2 \times 50 \times 50 \times 10 \times 22}{40 \times 25 \times 8 \times 7} = 353.57$$

= inches wound on bobbin per minute at commencement of set.

$360.93 - 353.57 = 6.36$ in. less wound on than are delivered from the rollers. This means either that the ends are somewhat slack or the 6.36 in. are taken up by twist.

The revolutions of the sun wheel might have been calculated from the main shaft and cone drums, but it is perhaps inadvisable to use this method, as the slip of the cone drum belt, with Holdsworth's differential motion, is an unknown factor, which may reach as high as 15 per cent., or even more in the case of the belt being slack. As touching this point, it may be of interest to note that a well-known inventor recently assured the present writer that with his new differential motion no allowance whatever was necessary for slippage of cone belt, on account of the motion running so lightly.

Most practical men, in finding the revolutions of front rollers, instead of making a calculation as indicated above, will simply find the revolutions by actual timing, and in practice this will generally be found the readiest method. The best plan is to have a slight nick or rough place cut on the end of the roller, and to hold the fingers of one hand to the surface, whilst a watch is held in the other hand. Such calculations as the above at times come in very useful when there is trouble with the rovings. Usually, however, the best practical method of putting the tension in the ends is as follows:—See that the cone belt is level with the ends of the drum immediately after doffing, and by actual examination ascertain whether the ends are of the proper tension during the first traverse of the lifter rail. If the ends are too slack or too tight, then the number of teeth in the wheel that drives the sun wheel may be increased or diminished as required. Occasionally the wheel at the end

of the bottom cone drum may be altered for this purpose. After the disposition of the first layer the ends are maintained at a correct tension by the ratchet wheel.

TWIST WHEEL.

In the Honours Grade of the paper of questions on Cotton Spinning recently set V (1896) at the Examination of the City and Guilds of London Institute there was a question on the twist wheel, which may very appropriately be answered at this point. The question referred to was No. 3, and read as follows:—"What parts of a roving frame are directly or indirectly driven from the twist wheel, and how are they affected by a change of that wheel?" So far as regards the extent of its connection, the twist wheel is by far the most important wheel about a bobbin and fly frame, although it is not, perhaps, so difficult to ascertain the exact size required for any counts of roving as in the case of the ratchet wheel. Being fixed on the inner end of the main shaft of the frame, it is connected, more or less, to every motion of the machine, with the solitary exception of the spindles. The latter are driven directly from the frame shaft, and have no connection with any other motive part of the machine.

The twist wheel drives the top cone shaft, and from a wheel on the end of this shaft the front roller is driven. Of course, the back and middle rollers are driven from the front roller, as in nearly every machine used in cotton spinning. Through the medium of the cone drums the twist wheel is connected to the lifter rail and to the differential winding motion. If the twist wheel were pulled off and the frame started, the rollers and the lifter would stop. The spindles would keep on revolving as usual, and the bobbins would also revolve, although in a bobbin-leading frame they would revolve at such a reduced rate of speed that no winding could take place. The chief

idea in having the twist wheel so intimately connected with almost all parts of the frame is that several things can be adjusted simultaneously by an alteration in the one wheel. If a little more or less twist were needed for the same hank roving, nothing but the wheel need be changed. The twist is regulated by putting a smaller twist wheel on for finer counts of roving. This smaller wheel drives the rollers more slowly, and allows the spindles to remain at the same speed as previously, so that the same revolutions of the spindle are made to a less delivery of roving, which of course means more turns per inch. A larger twist wheel will obviously have the opposite effect. It is not quite so easy to comprehend the exact effect of a change in size of twist wheel upon the speeds of the lifter and the sun wheel. Referring in the first instance to the lifter, this is made to go more slowly by a less twist wheel being put on, and some carders seem to imagine that no further attention need be paid to this vertical traverse of the lifter. This may do for a small change, but it will not do for a change in counts of any magnitude. In this case the less twist wheel diminishes the speed of the lifter traverse sufficiently to compensate for the reduced rate at which the rollers deliver the roving. But this does not meet the case. The lifter also requires to be traversed more slowly to compensate for the roving being made thinner or finer, and with this effect the twist wheel has nothing to do. Granting that the lifter wheel is a driver, a less wheel should be put on for finer hank roving to compensate for the diminution in diameter of the latter. So far as the sun wheel is concerned, a less twist wheel will cause the sun wheel to revolve more slowly, which means that the bobbins will revolve more slowly in a bobbin-leading frame, and more quickly in a flyer-leading frame. In either case, compensation is made in the winding for the reduced rate at which the roving issues from the rollers, and this does all that is required until the com-

pletion of the first layer. The first layer being deposited upon the bobbin, it is necessary, all through the set afterwards, to make compensation in the winding, also for the thinner nature of the roving, in addition to its slower rate of delivery by the rollers. As every layer of roving put on the bobbin is thinner than when on the previous hank roving, it is necessary to ease the winding to a less degree than formerly at every change. This second effect is produced by putting on a larger ratchet wheel.

NATURAL TWIST IN THE COTTON FIBRES.

To what extent the natural twist in the cotton fibres affects the quality of the rovings and yarn is a moot point. This can scarcely be wondered at, considering the different opinions which prevail regarding the extent of the twist.

Mr. C. P. Brooks, on page 16 of his "Cotton Manufacturing," gives it as 300 to 800 convolutions to the inch. In Witham's "Questions and Answers," on page 1, we are told that "the number of convolutions, or twists, per inch, vary from 500 to 800 per inch." Mr. Marsden, on page 49 of his "Cotton Spinning," says:—"The microscope shows them to amount from 100 to 300 per inch, and closer investigation would probably show a wider variation than even this." The observations of Mr. Midgely, of Bolton, and also certain investigations by the author, confirm the latter statement, at any rate for Egyptian cotton, as he gives an average of about 180 twists per inch. Mr. Monie gives it as "twisted several times in its length." The writer has met with a good number of practical men who have attributed certain peculiarities in their yarn to the effect of natural twist in the fibres, when there has been little doubt the real cause lay in the amount of twist put into the roving at the frame, and in other circumstances. To take a case in point. A mule overlooker of the writer's acquaintance has long had some of his mules spinning pin cop weft with the spindles revolving twist, or

right way, and at the same time some of the adjoining mules have been spinning pin cop weft with the spindles revolving weft way. The latter mules have spun worse than the former for a long time, and the overlooker has attributed it to the assumed fact that the cotton fibres were all twisted to the right, and this had a strengthening effect upon the twist way yarn, and a detrimental effect upon the weft way yarn. The writer gave it as his opinion that this was rather an improbable assumption, and since then it has been conclusively proved that much of the difference in spinning was the result of difference in the setting and regulation of the mules themselves. As a matter of fact, however, it does appear, from actual practice, that mules spinning weft way require rather more calculated twist than mules spinning twist way in order to obtain the same indicated turns per inch. For instance, in one case well known to the writer, when certain mules are changed from weft way to twist way—which often occurs with these particular mules—it is the practice to put on a rim pulley half an inch less in diameter than the rim used for the weft way yarn. It is the writer's opinion, however, that this is due to most bobbin and fly frames having their spindles to revolve to the right, thus giving a certain bias to the fibres; and also because a very slight amount of the twist, as shown elsewhere in this treatise, is still left in the roving, even after it has gone through the rollers of the mule. There are some good authorities, however, who seem to think that the fibres are all twisted one way, and the natural twist does affect the yarn according to the direction in which the latter is twisted. In view of these opinions considerable interest attaches to the statement upon this subject made by Mr. Midgley, of Bolton, to the effect that the twists in the same fibre are often some of them to the right and some of them to the left. This is going further even than saying that some fibres are twisted to the right and some

to the left. There are various effects attributed to natural twist in the fibres which owe their effect, without doubt, to other circumstances. For instance, in the discussion following upon a recent brief address given by the present writer to the Stalybridge Managers' and Overlookers' Society, one of the members stated that at their mill they always spun their weft, or filling yarn, with the spindles revolving weft way, or to the left. For years they had made their own cloth from this weft, and had served a well-known cloth merchant with every satisfaction. Owing to an extensive breakdown in the spinning department of the mill they at one time had to buy their weft, or filling yarn, for some weeks. Shortly there came serious complaints from the above cloth customer that the cloth would not take dye properly, and asserting that they must be using inferior cotton, and interfering with the twist to make up for it as far as possible. Now, as a matter of fact, cloth made from cotton containing a large proportion of unripe fibres will not take dye properly, owing, probably, to the absence of the hollowness which is characteristic of well-developed fibres. It was quite certain that the faulty cloth was made from the bought yarn, and naturally suspicion fell upon this yarn. Soon, however, it was proved that this yarn was of good quality, and made from good cotton. Subsequently it was proved that the defect in the cloth was all owing to the bought yarn being twisted in the opposite way to their own weft. The gentleman quoting the foregoing circumstance considered that natural twist had something to do with the difference, but it is more probable that it was owing to the cloth containing the weft way yarn requiring treating a little differently to that containing the twist way yarn, and also to the fact that weft twisted to the left will probably amalgamate better with ordinary warp yarn than weft twisted to the right. In proof of this, another gentleman at the same meeting quoted a similar circumstance in his own experience. At

their firm they had both spinning and weaving, and used all their own yarn. Owing to a breakdown they used some weft yarn twisted in the opposite way to their usual weft. Soon after some of the cloth was sent back to show that it was not taking the dye as well as usual. Upon glancing down the cloth one way it appeared to be all right, but glancing down it the other way about, it could be seen that certain places had not taken the dye efficiently. It was conclusively established that it was all owing to the weft being twisted the opposite way to usual.

TENTERS.

It goes without saying that slovenly and careless tenters are a source of much bad work and many mishaps to the frames. In the latter connection may be mentioned spindles getting fast. The spindles have to be made a very good fit inside the bolster bearings, and yet at the same time there must be sufficient freedom for the collars, or bolsters (whether long or short), to slide up and down the spindles to the extent of the lifter traverse. The difficulty of providing and maintaining these two opposite conditions is increased from the fact that fly can so easily accumulate on the spindle. It is a frequent occurrence indeed for a spindle to get fast—*i.e.*, for the spindle and collar to lock together, and the spindle to be then carried upwards or downwards with the lifter until the frame is stopped. A tyro would be astonished to see how firmly a very small piece of waste will bind the spindle and collar together. When this occurs the under carder is usually fetched, and he has to take the bolster and spindle out, and take such steps as are necessary for loosening the spindle. A ready plan is to knock the collar against the edge of the frame end. It is astonishing how frequently a careless tenter will have spindles fast by neglecting oiling or cleaning. An assistant carder grumblingly remarked to

the writer some time since, when engaged in looseing a spindle: "This is a sick tenter (intermediate frame), and this is the third spindle I have had to loosen to-day." Another common fault with indifferent tenters is to make long or hard piecings when the ends have been down. It is often necessary when piecing an end at the front of the machine to put a little twist into the roving by hand. In order to effect her piecings more readily, a careless tenter will put much more twist in than is absolutely essential, with the natural result that it is sure to break, either before it passes through the rollers of the spinning machine or immediately after. Sometimes the tenter will wrap the end loosely round the bobbin without effecting a piecing at all. Such tenters will neglect oiling and cleaning the rollers, and will allow roller laps to form, with manifestly injurious effects to the quality of the roving. In other ways they will spoil the cotton, and some of these have been previously described in this series of articles. Small lengths of "thick" or "single" are caused by tenters making long piecings when creeling in the case of the "thick," and by letting one end run through the rollers before attaching the other end in the case of "single." These short lengths are most annoying to the spinner.

Running over and under at the conical ends of the bobbins is often caused by carelessness on the part of the tenter in stopping the frame just at the change. This liability to fall off is probably the worst defect of the special method adopted on fly frames for shaping the bobbins, so as to permit of handling and transference from one machine to another with a minimum amount of damage to the roving. In this respect these frames are identical with the mule, as in each case the finished article is wound in the shape of a cylindrical body with conical ends. In some machines, as, for instance, the ordinary cop-winding frame for preparing warpers' bobbins, flanges are put on the bobbins. In the quick traverse drum-

winding machines—which in one form or another are beginning to be largely used—the same object is attained by crossing the threads in rapid manner from one edge of the bobbin to the other. Neither of the two latter methods, however, is practicable on the bobbin and fly frames. Speaking on the subject of the lifter traverse, it will be interesting to note that there is an idea taught in one or two good text-books, and somewhat extensively believed in by many intelligent students and practical men, to the effect that the time occupied by any one lift is the same at all parts of the set. This belief, doubtless, arises from the fact that the rate of speed of the lift, or traverse, is reduced at every change of the lift in the same proportion as the diameter of the bobbin is increased. It is, however, an erroneous idea. A short time ago the writer, in order to slightly test the matter in a practical manner, compared the top and bottom layers put on bobbins made at slubbing, intermediate, and roving frames. The layers made at the finish of the set in every case weighed more than the layers made at the commencement of the bobbins. It may also be pointed out that the taper, or cone, in the ends of the bobbins may be more or less, quite irrespective of the speed of the lift, and it is the amount of taper which causes the upper layers to be heavier or lighter, as the case may be, but we believe that in all cases the top layers will be found to contain a greater length of cotton than the bottom layers.

THE PRESSER.

Strained pressers are often the cause of weak rovings and poor bobbins, although it is questionable whether this is as much so as in the days when double press flyers were so prevalent. The presser is a splendid little contrivance, as it not only enables the weak roving to be guided upon the bobbin with that particular length of rove just passing upon the bobbin—extending in a horizontal line, but it also contributes very materially to the hardness of the bobbin.

In this respect, as we have said before, its position is analogous to that of the counter faller weights, or salmon-head levers, of the mule. The presser, however, in some degree combines the virtues of the winder faller wire and counter faller wire of the mule, as it both guides the roving on the bobbin and makes the latter harder. A still better comparison is with the traveller of the ring frame, which both guides the yarn and causes the spools of thread to be built firmly, according to the weight of the traveller. It is possible that the traveller is, in some respects, superior to the presser, as it is only in the middle of the set that the latter is in perfect balance—at any rate, with single pressers. The presser, again, cannot be so readily and economically changed as the traveller, when the exigencies of mill practice compel a considerable variation in the counts of material being made. There is a great tendency in American spinning mills at the present time to change from about 5-hank roving—to be put through single at the mule—to about 11-hank roving, Egyptian cotton, to be put up double at the mule and spun into 70's or 80's, the American cotton having been spun into 40's or 50's. In such cases the writer can testify, from actual experience, that it would be a decided benefit if the presser could be as readily changed as the traveller. On the other hand, it is one of the worst defects of the ring spinning system that the traveller cannot be accommodated to such tender material as the presser can. Double press flyers, and flyers without pressers, seem to have given way to the single press in much the same way that Wellman flat cards and double rolier and clearer cards have given way to the all-popular revolving flat. In changing to a much finer hank roving, there is also the size of the slit in the hollow flyer leg to be considered. If it be too large, then the roving will have a nasty trick of flying out at times. It is comparatively easy to close the slits, but it is not so easy to open them again, if ever it becomes necessary. In some

cases these apertures are curved, with the object of stopping the roving from flying out.

BAD ROLLERS.

The writer has often found bobbins which felt extra hard, and which, upon being wrapped, indicated the roving to be considerably coarser than the proper hank. Upon examination, it has been found that the front roller, through which the roving passed, was dirty and dry, and consequently did not revolve quickly enough—thus failing to attenuate the roving sufficiently. Shell rollers, although more expensive than fast rollers, are less liable to get fast with dirt than the latter. Greater care in having good oil, however, is necessary with loose than with fast boss rollers, simply because the former are only re-oiled every few weeks, usually. The writer has often known bad rovings and yarn to be made from loose boss rollers, which, upon examination, have proved to be quite hot and dry only a day or two after oiling. Metallic drawing rollers are very free from such defects as these, and also from various other defects appertaining to leather-covered top rollers. It does not appear, however, that they are very likely to receive much adoption in processes subsequent to the drawing frame. Possibly a more likely thing to meet with success on bobbin and fly frames are the recently-adopted loose ends for leather-covered rollers. The writer has had an opportunity of testing the merits of these loose ends, and has been very favourably impressed with them, at any rate for drawing frames. They offer great facilities for oiling and retention of oil, with little friction, and with the bearing surfaces well covered in, so as to keep them clean. Fluted leather rollers are often a great bugbear and source of annoyance to all concerned. Where fluted leather rollers are found we may expect to have soft bobbins and irregularly drawn rovings.

It is often a most perplexing matter how to avoid fluting. Practical men of any standing can usually tell of certain frames, or particular portions of frames, which fluted the leather rollers, no matter what remedies were provided. There is no doubt that in many cases fluting has been extensively brought about owing to the desire of the management to economise by giving a less price for the roller leather. The latter is expensive, and small blame attaches to individuals who are tempted to cut the price down in these days of small profits. Too much care, however, cannot be exercised in this matter, as leather containing thick and thin places, and having little pliability, and which cracks and opens when doubled up, is dear at a gift. There is the expense of putting it on the rollers and into the machine, and it will shortly flute and spoil the roving, and of course will have to be taken out and renewed. Numberless illustrations of this point could be made from actual experience, but we will content ourselves with a single instance. At a certain spinning mill great trouble and annoyance were caused by the rollers in the frame-room fluting almost as soon as put in. Various expedients were resorted to for overcoming the difficulty, with little success. The frames had just been put on a finer hank roving, and it was thought that the roller weights were too heavy, and several pounds were spent on equipping one frame with new weights as an experiment. Little or no benefit was derived even from this extreme measure. Subsequently it was admitted that an inferior leather had been purchased, and, upon reverting again to the original quality, the fluting disappeared. The weights for the rollers of bobbin and fly frames are often on the slubbing and roving frames about 18lbs. front roller, 14lbs. middle roller, and 10lbs. or 11lbs. back roller. On the intermediate frame the weights are generally less than the roving frame, because of the rollers having a less number of ends to them—say, 14lbs. front roller, 10lbs. middle

roller, and 8lbs. back roller. Often heavier weights are placed on the back than the middle roller. It is the experience of the present writer that it is difficult to see any effect upon the rollers on cotton by making these weights a pound or two lighter or heavier. It is well to remember that with short rollers there is less chance of variations in the thickness of the leather coming together than in long bosses. For the finer numbers it appears to be pretty well established that self-weighting of the back and middle rollers, with dead weights to the front and one end to a boss, are the best conditions, both on the ring frame and the mule, and the bobbin and fly frames, for producing the high quality of yarn required. As regards the ring frame, the above conditions are pretty much the same for the lower numbers.

A short time ago reference was made in these articles to the ratchet wheel on speed frames. The writer, however, on that occasion omitted to mention an important point in relation thereto.

In regard to the builder wheel of a self-acting mule, the writer has frequently found very variable results obtained when changing counts and working by a given rule. Some good authorities have emphatically given simple proportion as being the most accurate, while others have been just as emphatic in giving rules which required the use of square root. The experience and observations of the writer in this matter, extending over a good number of years, may be summarised as follows: For low counts of yarn—say anything below 20's—simple proportion, without the use of square root, seems to answer best, while for finer yarns—say anything above 40's—rules which require the use of square root appear to agree better with actual results. Generally speaking, however, when simple proportion is used we may expect that the change in the wheel will be too great, and allowance must be made for this. For instance, if the wheel were being

changed from a 24 to 33 (calculated) it would be better only to put on a 30 or 31. On the other hand, if square root were used, the change in the wheel, as given by calculation, would not be enough, and if the calculation gave a change from 24 to 28 it would probably be better to put on a 30. The observations of the writer lead him to think that exactly the same kind of reasoning and practice will apply to the ratchet wheel on speed frames. All the text-books agree in giving rules requiring the square root principle for the ratchet wheel on these frames. A common rule is: "Square the wheel on; multiply this square by the hank roving required, and divide by the hank now making; extract the square root of the quotient, which will give the required wheel." To take one case in point: A frame was changed from 4 to 11 hank roving—there was a 28 wheel on for the 4 hank. By the rule we get

$$\frac{28^2 \times 11}{4} = 2156 \text{ and } \sqrt{2156} = 46.43.$$

As a matter of fact a much larger wheel than this was put on, the exact wheel being a 54. In addition to this, although various alterations and adjustments were made to get a ratchet wheel on, as, for instance, at the wheel on the upright shaft driving the long rack giving the traverse of the cone belt. The above change of hank is, of course, a wide one, but it serves to show the importance of the point under notice more clearly. Similar alterations have been made in various mills during recent years in changing from American cotton single roving to Egyptian cotton double roving. There appears to be a tendency with some spinners to perform somewhat analogous operations at the present time, and to these the hint given may be of service.

Most of the readers of this treatise will be perfectly aware that the late Mr. Evan Leigh, in his large work on cotton spinning, gave it, as a "secret worth

knowing," that spinners ought to have their slubbing spindles revolving to the left or weft way, the intermediate spindles to the right, the roving to the left, and the mule again to the right. Led on by this opinion, many spinners using double roving at the mule have at various times tried the idea. It should be said that the advice was only intended for double roving at the mule. On the whole, the writer's opinion is, that this "secret" is a decided failure from a practical point of view. There are spinners who have tried it who seem to think they get a somewhat stronger yarn, but it is significant that after one preparation has been made in this way and tried for some time, they do not see their way to make further changes of the kind.

There is one feature in the system which makes some carders and tenters abhor it. With the frames mixed up in this way it is a difficult matter to get them worked efficiently, as it practically means beginning again to the frame tenter who has been used to twist way frames. The machine makers at the present time—although they are prepared to make weft way frames—very seldom obtain any orders for them, and it may, therefore, be deduced that this great "secret" is of little practical value. When changing a frame either from twist way to weft way or *vice-versâ*, the practical rules given subsequently in this chapter will be found of great service.

Whilst on this point, it may be said that another precept of the same inventor for speed frames, has been equally unsuccessful. This consisted in controlling the upward and downward movement of the lifter rail by vertical screws, instead of the lifter racks and pinions now universally at work, in order to prevent any dwelling of the lifter rail at the change of lift. The plan had been previously attempted, but was discarded chiefly on account of excessive wearing of the parts. A short time ago a leading machinist assured the writer that there was

nothing in the idea at all, and they could easily obtain the same benefits by having the balance of the lifter and the lifter weights to preponderate on one side. In some cases it is an extremely difficult matter to obtain well-built roving bobbins, simply because the frames are laid on a shaky and unlevel floor. Formerly spinners did not appear to attach anything like the amount of importance necessary to this point, and would have frames erected in old rooms, and bad floors in upper rooms, with the result that the bobbins were, to a large extent, of a defective character. At present not only are the floors much more solidly constructed, but it has become a very general practice to adopt the wise plan of putting the frames upon the ground floor.

There are many old frames running which give as great a production, and almost as good a bobbin, as frames on the latest principle. As a matter of fact there are, perhaps, less really satisfactory and generally appreciated improvements upon these frames than on any other machines in the mill. We are quite aware that such things exist as "duplex driving, cone-releasing motions, electric stop motions, improved differential motions," etc., but none of these are universally accepted by all spinners. Let these be compared with the revolving flat card, or with details of the mule, such as rope taking-in, etc.

There is always a sort of pressure being put upon spinners from one source or another to make alterations in their frames, so as to include some of the more recent improvements, but in such cases a careful consideration of local circumstances should be made before any steps are taken, or otherwise the trouble and expense of the changes may only result in the spinner finding that no improvement has been effected either in quantity or quality of roving produced. Indeed, numerous instances could be quoted, in which matters have actually been worse after the alterations than they were previously.

Sometimes rovings become seriously damaged by leakage in steampipes, which run over the top of the position in which the bobbins are placed, either in the mule room or in the frame room. It is astonishing how much damage will be allowed to result to the rovings at times by such simple matters as this before the remedy is provided. Often, of course, a mechanic is not to hand, and the carder or overlooker does not understand enough about the pipes and valves to provide a means of remedying the leakage with facility and efficiency, and so the matter is allowed to drift on day after day.

TEST WITH FLYER LEAD.

To show practically on a flyer lead frame that the bobbins revolve quickest when full, we turned the spindles 20 revolutions with the cone belt set for empty bobbins and found the bobbins to make 16 revolutions in same time. Then we put belt as for full bobbins and found $18\frac{3}{4}$ revolutions of bobbins to spindles, 20.

TEST OF BOBBINS BY WRAPPING DIFFERENTLY ROUND

PRESSURE FINGER AND FLYER TOP.

Eight bobbins were taken by the author, and the cotton was conducted in each case round the flyer top or round the presser finger, in such a manner that no two bobbins were alike.

No. 1.—The cotton in this was taken $\frac{1}{4}$ round the flyer top, and straight from the flyer leg to the bobbin without wrapping round the presser at all.

No. 2.—This end was taken $\frac{1}{4}$ round the flyer top, and once round the presser finger.

No. 3 was taken $\frac{1}{4}$ round flyer top, and twice round presser.

No. 4 had the slubbing end taken $\frac{1}{4}$ round the flyer top, and three times round the pressure finger.

Nos. 5, 6, 7, 8 were each taken $\frac{3}{4}$ round the flyer top, No. 5 being not wrapped round the pressure finger at

all, and Nos. 6, 7, 8 being respectively passed one, two, and three times round the pressure finger.

The frame having been worked until the bobbins were partially filled, the following conditions were noted or ascertained respecting the eight different bobbins:—

No.	Diameter of Bobbins in inches.	Weight of 30 yards.	Counts.
1	Dofted too soon, but about twice that of 4	270	·925
2	$5\frac{1}{8}$	301	·830
3	$4\frac{5}{8}$	322	·776
4	$4\frac{3}{8}$	378	·661
5	Dofted too soon, but about $1\frac{1}{2}$ that of 8	337	·742
6	$4\frac{5}{8}$	354	·706
7	$4\frac{1}{8}$	377	·663
8	$3\frac{7}{8}$	403	·620

NOTE.—The wrap reel for slivers and rovings is usually one yard in circumference, and this facilitates counting any number of yards being wrapped.

It will be noticed that the counts work out finer for ends that were conducted least round the flyer top and the presser finger, the finest of all being No. 1, which was wrapped least round of any; and the coarsest being Nos. 4 and 8, which were wrapped most round the flyer top and the presser. This is contrary to what many people would expect to be the case, as it is natural to assume that the more the cotton is wrapped round the flyer and the presser, the more drag it will be subjected to. Whilst this is quite true, it must be remembered that, on the other hand, the ends that were wound least round the flyer top and the presser made soft pulpy bobbins, whose increased diameter soon began to overwind the cotton and to pull it out finer. The roving from No. 1 bobbin, although wound least round the flyer top and presser finger, was the finest of all, and had hardly any strength whatever, because its non-passage round the flyer and presser allowed it to more readily yield to the draft

caused by enlarged diameter of the bobbin. The bobbins, Nos. 4 and 8, were just as solid and hard as No. 1 was soft, No. 8 especially being almost as solid as a stone. Nos. 1 and 5 had to be doffed somewhat early, because by passing the cotton straight from the flyer to the bobbin, it was not guided on to the bobbin properly at the ends and ran off, so as to form shapeless bobbins, especially No. 1. All the other six bobbins were well formed, with the exception that No. 8 was ridgy in the coils, owing to the great amount of drag and thickness of the roving.

This test is of much greater practical importance than many people have any idea of. We have been, times without number, asked by students and others what effect would be produced by such variations in passing the cotton round the presser and flyer as were made in the foregoing test. We have often known managers to give instructions for the ends of the roving frame to be passed once more or less—as the case may be—round the presser finger. Usually this gives very unsatisfactory results, because it is surrounded by other circumstances which make it a somewhat complex matter. To take a case in point. A short time since, a certain manager of the writer's acquaintance, gave instructions for all the roving frame ends to be conducted one more time round the presser finger with the idea of getting the bobbins harder, and also putting more cotton on the bobbins. These objects were very clearly and satisfactorily obtained, but after the bobbins had been running for some time in the mule creels, there was a great outcry from the spinners that the rovings were ratched and uneven, and refused to pull from the bobbins, and orders had to be given at once for the former condition of things to be reverted to. There is no doubt, in our opinion, that any alteration in amount of wrapping round flyer top or presser finger will require some alteration also in the number of teeth in the ratchet wheel. Whilst variations in wrapping round the presser finger or flyer

top, and variations in size of ratchet wheel—both affect the hardness of the bobbin—we are inclined to think that the better and more legitimate method of obtaining harder bobbins is to have the presser arms and fingers balanced differently. The harder nature of the bobbins obtained in the foregoing test was at least partially due to the cotton coming out coarser. In making such a change a larger rack wheel ought to put on, in order to tension the ends more in accordance with the diminished diameter of the bobbins. We strongly urge that the best possible practice in this matter would be for some very competent person to determine the exact practice to be followed in wrapping the cotton round the presser finger and flyer top, and then to determine the correct rack wheel for those conditions. In doing this all calculations ought to be checked by careful wrapping of the rovings for different sizes of the bobbins, along with comparisons as to hardness, &c., and observations of the tension of the ends. Our experience and observation is, that a great many rovings are made under more or less false conditions. It must be especially noted that a roving after being led from the rollers, and passed through the eye in the side of the presser top, must be conducted partially round the flyer top *in the same direction as the flyer is revolving*, on to the left hand, otherwise the twist will not pass properly into the rovings. In a frame running weft way the rovings would be wrapped to the right, round the flyer top. This point is of paramount importance.

TEST OF SLUBBING FRAME BOBBINS.

In order to ascertain approximately the number of layers on a bobbin and the diameter of the slubbing, and to see also whether there was any expansion in the bobbin diameter, other than what was legitimately due to thickness of each layer, the following test was made by the writer. A slubbing bobbin of .82 hanks, and about four-fifths full, with the total amount of cotton on the bobbin weighing about $1\frac{1}{2}$ lbs., was taken for the test.

	Diameters.	Amount of diminution for 8 layers.
Bobbin $\frac{4}{3}$ ths full	$4\frac{1}{16}$ inches	$\frac{7}{16}$ inch
„ 8 layers less	$4\frac{1}{4}$ „	$\frac{7}{16}$ „
„ 16 „ „	$3\frac{1}{8}$ „	$\frac{7}{16}$ „
„ 24 „ „	$3\frac{3}{8}$ „	$\frac{7}{16}$ „
„ 32 „ „	$2\frac{1}{2}$ „	$\frac{7}{16}$ „
„ 40 „ „	$2\frac{1}{4}$ „	$\frac{7}{16}$ „
„ 48 „ „	$2\frac{1}{8}$ „	$\frac{7}{16}$ „
„ 56 „ „	$1\frac{5}{8}$ „	$\frac{7}{16}$ „
Empty bobbin.....	$1\frac{5}{8}$ „	

From the above table it will be seen that no difference in diameter was found other than that due to the thickness of the slubbing itself. In other words, 8 layers of cotton gave the same variation in diameter at the full, half full, and empty bobbin, and not, as some have contended was the case, more in one part of the bobbin than another. In the same bobbin there was practically twice as much cotton contained in one layer of the full bobbin as in a layer taken off when the bobbin was almost empty, the respective lengths being, $20\frac{1}{4}$ yards for the full bobbin and $10\frac{1}{2}$ yards for the almost empty bobbin.

It will be noticed that according to the above table the roving was 3.0625 inches diameter for 56 layers. This gives the diameter of one layer to be .05468 inches, and as in each layer there are two diameters of roving taken, the diameter of one would be $.05468 \div 2 = .02734$ inches. When the cotton is poorer and softer than usual the bobbins will tend to build up softer and larger than they usually do.

ON INCREASING DIAMETER OF FULL BOBBINS.

We have been frequently referred to by overlookers and managers who have been desirous of getting a greater weight of cotton on their bobbins as to the best method of making the requisite alterations. Take a case in point, say, changing from a bobbin of $4\frac{1}{2}$ inches diameter to one

of 5 inches diameter. There are two chief questions to be considered. (1) Is there sufficient room between the legs of the fliers? If so, all right; but if not, it will be necessary to get new fliers to accommodate the larger diameter of full bobbin. (2) Is there a sufficient amount of unused cone drum when the bobbins are full with the smaller diameter of bobbins to allow of the extra diameter of bobbin being added? If so, no alteration whatever need be made. In many cases, however, practically all of the cone drum is used up for the smaller diameter of bobbin, and, therefore, some steps are requisite to provide for this condition. It is here where the greatest difficulty comes in. Many people consider that it is only necessary to make a re-arrangement of the various wheels in order to get a larger rack wheel on, so as to reduce the speed of the traverse of the cone drum belt. It is the opinion of the writer, however, that no such re-arrangement of the wheels can be made so as to give thoroughly satisfactory results, providing, of course, that the wheels were previously arranged correctly so as to produce a well-made, equally drawn and wound roving. It appears to us that the only really correct method is to get new cone drums carefully designed and made. If there is room, it will perhaps be the better plan to have them made with the same degree of concavity and convexity, but rather longer, in which case no wheels will want altering. If there is not room on the frame for longer cones—as is frequently the case—then the new cone drums may be of the same length, but they must have a greater degree of curvature, *i.e.*, one inch in length of the cone drums must show a greater variation in diameter than previously. Or what is the same thing, a certain given amount of easing of the winding must be obtained by a less length of cone drum than previously. This will be understood best by a reference to, and comprehension of, the principles involved in the construction of a new pair of cone drums, as

explained elsewhere. A larger rack wheel must also be put on in this case.

ON VARYING DIAMETER OF EMPTY BOBBIN.

It has been suggested to us at various times that the empty bobbin might be made of larger diameter, and the difference for the first layer met by diminishing the speed of the sun wheel by an alteration in size of one of the wheels that drive it. This, it has been suggested, would enable the cone drum belt to be started at the initial end of the cone drums as usual, thus enabling the same cone drums to serve for larger diameter of full bobbin. This we can scarcely agree with, although it is a course we know to have been followed in making the diameter of empty bobbin greater in certain cases with some show of success. Suppose we take an extreme case of changing the diameter of empty bobbin from 1 inch to 2 inches, and the difference in the speed of bobbin for the first layer is met by diminishing speed of sun wheel as suggested above. When $\frac{1}{8}$ th of an inch is added to the diameter of the new bobbin, the "winding speed" will only require to be diminished by $\frac{1}{17}$ th part, whereas for the 1-inch bobbin the addition of the first $\frac{1}{8}$ th inch diameter would have necessitated a diminution of "winding" speed of bobbin by $\frac{1}{6}$ th, as we have said before. The best and simplest method of meeting an increase in diameter of empty bobbin, as when changing from short to long collars, &c., is to start the cone belt further up the bottom cone drum to a sufficient extent to keep the ends nicely tight the first layer. Afterwards it will rectify itself without any alteration whatever in any of the wheels. If, however, the management are determined to try starting the belt at the extremities of the cone drum, then, in addition to slowing the sun wheel, a larger rack wheel should be put on, so as to let each movement of the cone belt give a less degree of easing to the winding. This, at any rate, may give approximately correct results,

although we must repeat that it would be better to fix the parts belonging to the cone belt so that the tenter, when doffing, can only wind the belt back to a position previously determined as being correct by the management. If the diameter of empty bobbin were reduced, there would be no option but to rectify the winding as well as possible by the wheels. Care should be taken never to mix empty bobbins together of different diameters as it would be impossible to get correct winding undur such circumstances.

SPECIAL LIFTER MOTION.

On many new slubbing and intermediate frames, there is applied a little contrivance by which the lifter can be wound up or down by hand. It is well-known that it is not advisable to stop bobbin and fly frames at the extremity of a lift when about to doff, as such a procedure leads to the ends of roving rubbing off the extremities of the bobbin, causing the ends to fly about and make waste. To prevent this a frame is usually stopped for doffing when part of a lift has been made. When the frame is re-started after doffing, the lifter proceeds to the end of its traverse and then is reversed so as to place a second thickness of roving upon the first, at that half of the bobbin before even one layer has been put upon the other half. This scarcely matters when the cotton is very thin as on the roving frame, but upon the slubbing frames, and sometimes also the intermediate frames, it has been deemed of sufficient importance to cause the invention and application of a small contrivance for its prevention. There are several wheels at the frame end, by which the lifter is driven, the final one of which is fixed on the lifter shaft. To this wheel is geared an extra small wheel fixed on a short shaft which extends through the frame end, and has, at its outer extremity secured, a hand wheel. Means also are provided by which the large lifter wheel in question can be disconnected readily from the wheels that drive it. Having

doffed, the tenter with this motion pushes a handle so as to disconnect the lifter from the cone drums, etc.; then, by means of the hand-wheel just mentioned, she winds the lifter to one extremity, and then puts the parts properly in gear again. It takes up only a very short time, and no difficulty is experienced in winding the lifter about, owing to its being balanced by the lifter weights.

CLEARER TRAVERSE.

In at least one make of bobbin and fly frame a little contrivance is applied, when required by which the flannel covered clearers for the leather rollers are made to have a lateral traverse, with a view to increasing their efficiency. Behind and beneath the frame there is attached to the lifter rail a large bracket containing a very large slot—say about 16 inches long—which is inclined to the vertical at an angle of about 30 degrees. A bowl fixed in the lower extremity of a long vertical lever works in this slot, the upper end of the lever being in contact with a thin rod running the full length of the frame just behind the drawing rollers. The upward and downward movement of the lifter rail oscillates the lever so as to give a lateral movement to the thin rod just described. At each end of this rod is attached a finger which presses against the end of the roller clearer at that end of the rod to which it is fixed. Whichever way, therefore, the thin rod is moved laterally, it pushes also the whole body of the flannel covered clearers in the same direction, and to the same extent. The extent of traverse, however, is adjustable, and the contrivance is only applied to the round revolving clearers used on fine hank bobbin and fly frames.

KNOCKING-OFF MOTIONS.

Most frames are fitted with one form or other of knocking-off motion for full bobbins. A great many are connected in some way or other to the traverse of the cone

drum long rack, and the latest forms aim at knocking the frames off so that a few loose coils of roving are placed on the top of the spindles, so as to be ready for doffing. Another desideratum to be aimed at is to knock the frame off at a point of the lifter traverse removed from the ends of the bobbins. Both points are certainly well worth aiming at.

Another well-known and very satisfactory motion is operated from the front roller in such a manner as to knock the frame off after a certain definite length of roving has issued from the rollers. For instance, in one case noticed by the writer, a front roller of $1\frac{1}{4}$ inches diameter had on it a single worm driving a change wheel of 35 teeth. On same stud as this 35 was a second worm, driving a second worm wheel of 36 teeth; on same stud as this 36 was a third worm, driving a third worm wheel of 24 teeth; on same stud as this 24 was a finger which liberated a rod, on which a lateral pull was constantly exercised by a weighted lever when the 24 had made a complete revolution.

$$\frac{10 \times 22 \times 35 \times 36 \times 24}{8 \times 7 \times 12 \times 3} = 3300 \text{ yds.}$$

If a greater length were required on each bobbin this would be obtained by substituting a larger wheel for the 35, and *vice versâ*.

ON RIGHT AND LEFT-HAND SKEW BOBBIN BEVELS.

It is well known that the fact of the long bobbin and spindle shafts being placed on one side of the spindles necessitates the use of skew gear bevels on these shafts. It is not so well known that on some frames these bevels are all one hand, while on other frames half of the wheels are right hands and half left hands. Take a frame with Holdsworth's motion, in which the bobbin-driving wheel

on the frame shaft invariably revolves in the contrary direction to the spindle-driving wheel by its side. Some frames have two carriers in the swing train of wheels with Holdsworth's motion, while there is only one carrier for driving the spindles, and the use of the two carriers for the bobbins causes the long bobbin shafts and the long spindle shafts to revolve in the same direction, although the first motors revolve in opposite directions. This allows the skew bevels for driving the spindles to be disposed similarly to those for driving the bobbins, and to be of the same hand.

On some frames, however, there is only one carrier in the "swing" with Holdsworth's Differential Motion, and the consequence is that the bobbins and spindles would revolve in opposite directions if other means were not taken to prevent them. In this case the skew bevels for driving the bobbins are placed on the opposite hand of the bobbins to what they are when two carriers are used in the "swing," thus giving them their proper direction of revolution, but necessitating the employment of a different "hand" of skew bevel to that used for the spindles. In frames containing one or other make of patent differential motion, the first bobbin-driving wheel invariably revolves in the same direction as the frame shaft, so that in these cases the "swing" needs only to contain one carrier in order to have all the skew bevels of the same hand. It is worthy of note that, although the long shafts for driving the front rows of bobbins or spindles always revolve the contrary way to the back shafts, it is not necessary to use right and left-hand bevels to counteract this, owing to the back shafts being placed at the back of the spindles, while the front shafts are placed in front of the spindles.

TWIST TO WEFT.

A better method than the one previously described of effecting this change, or its opposite; where right and left-

hand skew bevels are used is as follows:—(1) Transfer all the bobbin skew bevels to the spindle shafts and all the spindle shaft bevels to the bobbin shafts. (2) Get all new flyers of the opposite hand. If the skew bevels are all one hand then all new ones of the opposite hand must be got, and of course put on the opposite side of the spindles and bobbins to that on which the former bevels were on. In transferring the bevels certain little alterations in the cover brackets will be necessary at various points.

TO CHANGE FROM WEFT WAY AND FROM FLYER TO BOBBIN
LEAD SIMULTANEOUSLY.

With right and left-hand skew bevels this can be done as follows. (1) Transfer all the bobbin bevels to the spindle shafts and *vice-versa*. (2) Reverse the direction of the sun wheel. (3) Alter any wheel that will put lifter to be going same way as previously. The same flyers will do.

MARKS ON CONE DRUMS.

Although we have never heard the idea suggested by anyone else, yet we are of opinion that it would be good practice on the part of our machine makers, to have certain marks put on the cone drums to correspond with certain diameters of the bobbins. For instance, a mark at which the centre of the cone belt should be opposite when the bobbin was 2" diameter; another mark for the centre of the belt to be opposite when the bobbin was 3" diameter, and for 4" diameter, etc. Every carder by simply comparing the diameter of the bobbin with the position of cone belt could then always readily ascertain whether he had the correct ratchet wheel on or not. The author believes this remark to be worthy of the attention of machine makers and managers.

CHAPTER XI.

CALCULATIONS ON DRAW FRAMES AND FLY FRAMES.

(1) 6 yds. of sliver from the draw-frame weigh 13 dwts.
10 grs. Find the hank sliver.

Rule.—Divide the weight reduced to grs. into 50.

$$(a) \quad 13 \times 24 + 10 = 322.$$

$$(b) \quad 50 \div 322 = \cdot 155.$$

(2) The front roller of a draw-frame makes 350 revolutions per minute, and is $1\frac{3}{8}$ inch diameter. There are five deliveries, and the hank sliver is $\cdot 155$. How many lbs. will be produced in a week of 45 actual working hours

$$\frac{11 \times 22 \times 350 \times 60 \times 45 \times 5}{8 \times 7 \times 12 \times 3 \times 840 \times \cdot 155} = 4357 \text{ lbs.}$$

(3) The hank carding is $\cdot 165$ and six ends are doubled together, and there is 5.5 draft in the frame. Find hank drawing.

$$\frac{5.5 \times \cdot 165}{6} = \cdot 15125.$$

(4) The hank drawing is $\cdot 158$ and the hank carding is $\cdot 147$ and six ends are doubled together. Find the draft in the machine.

$$\frac{6 \times \cdot 158}{\cdot 147} = 6.45 \text{ almost.}$$

(5) The hank drawing is $\cdot 170$ and six ends are doubled together, and there is 6.4 of a draft. Find the hank carding.

$$\frac{.170 \times 6}{6.4} = .159.$$

(6) 6 yds. of card sliver weigh 305 grs., and the draft is 5.5, and six slivers are doubled together. Find the weight of 6 yds. of draw frame sliver.

$$\frac{305 \times 6}{5.5} = 332.7 \text{ grs.}$$

(7) 6 yds. of card sliver weigh 310 grs., and 6 yds. of draw-frame sliver weigh 300 grs., and six ends are doubled together. Find the draft.

$$\frac{310 \times 6}{300} = 6.2.$$

(8) 6 yds. of sliver at the last head of drawing weigh 300 grs., and we have a 35 change pinion on. Find change pinion to make 6 yds. of sliver weigh 325 grs.

$$\frac{325 \times 35}{300} = 37.9$$

(9) The hank sliver at the last head of drawing is .168, and there is a 42 change pinion on. Find change pinion to make .135 hank sliver.

$$\frac{.168 \times 42}{.135} = 52.2$$

TO FIND DRAFT BETWEEN CALENDER ROLLERS AND FRONT ROLLER OF DRAW FRAME.

Some good carders are decidedly of opinion that a slight draft at this point is very advantageous, as it leaves less work for the slubber rollers, and certainly does no harm to the sliver at the draw frame. The diameter of the front roller is $1\frac{1}{4}$ in., and the diameter of the calender rollers is 3 in. A 21 on the front roller drives, by means of a carrier, a 48 on the calender roller. Find draft between these two points.

$$\frac{21 \times 3 \times 3.1416}{48 \times 1.25 \times 3.1416} = 1.05 \text{ draft.}$$

It ought to be said that some other good carders will not have these "false" drafts on any of their machines.

THE COILER.

There is necessarily a slight amount of twist imparted to the sliver by the revolving action of the coiler plate, and it will be of interest to some practical men to have a method given by which the amount of this twist can be ascertained. We will take the actual sizes given in Messrs. Brooks & Doxey's lecture diagram of the draw frame, and a reference to that diagram will show that the coiler and the calender rollers are both driven from the front roller. A 20 drives a 48 on the 3in. diameter calender rollers. By means of carriers the same 20 drives a 46 on top cross-shaft. An 18 on this shaft drives a 20 on stud, and a 42 drives the 69 coiler wheel. The twist per inch can now be found in one operation from above dimensions as follows:—

$$\frac{20 \times 18 \times 42 \times 48 \times 7}{46 \times 20 \times 69 \times 20 \times 3 \times 12} = .0606 \text{ twist per inch}$$

or, practically $\frac{1}{16.6} = \frac{1}{17}$ of a twist in one inch of sliver. Therefore—

$$\frac{1 \times 1}{.06} = 16.6 = \begin{array}{l} \text{inches of sliver passed through calender} \\ \text{rollers to one twist or one revolution} \\ \text{of coiler.} \end{array}$$

COILING OF SLIVER.

Each coil of sliver is generally deposited in the can, so that it shall extend from the circumference of the can to just beyond the centre, leaving a clear passage down the centre. In some few cases, however, each coil only extends from the edge of the can to touch the centre, and not to go beyond. By this means more cotton is got in can, but the different coils are more likely to become entangled with each other. In some cases, more particularly for fine numbers, within the can is placed a sliver easing motion. It consists of two discs connected by a

spiral spring, which lifts the sliver up and takes the strain off it as the can becomes empty.

NUMBER OF COILS TO ONE REVOLUTION OF CAN.

The following is a ready method of determining the number of coils deposited during one revolution of the can. The coiler and the can bottom disc are both revolved from the top cross shaft, and we may assume for the moment that the can bottom wheel drives the coiler top, and find the revolutions of the latter to one of the former. Taking again the sizes given in the lecture diagram we obtain—

$$\frac{1 \times 104 \times 35 \times 34 \times 20 \times 18 \times 42}{20 \times 10 \times 18 \times 18 \times 20 \times 69} = 20.92 \text{ coils of sliver deposited in one revolution of the can.}$$

This number of coils, therefore, depends absolutely upon the relative velocities of the can and the coiler plate.

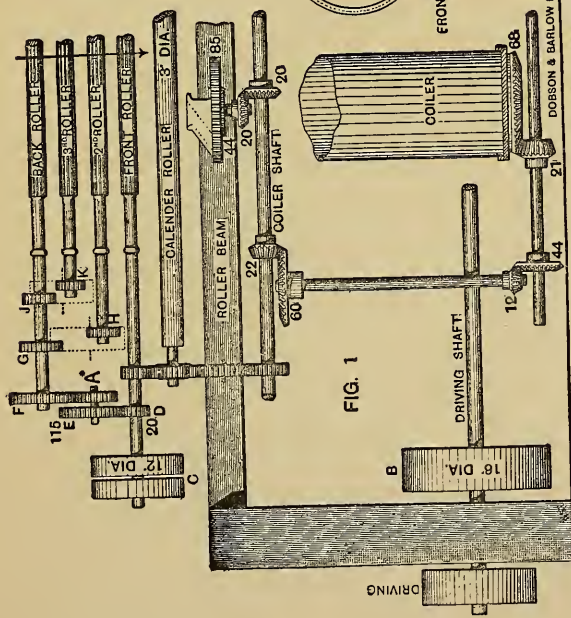
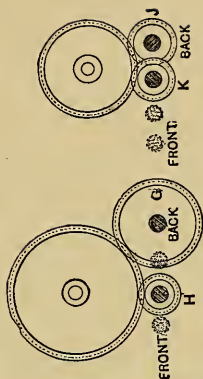
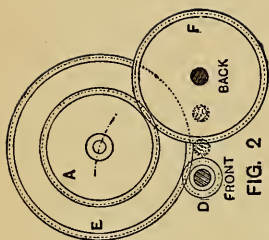
SIZE OF COIL.

The size of each coil depends upon the amount of eccentricity in the coiler plate. If the distance from centre of top hole of plate to centre of bottom hole or outlet be $2\frac{1}{2}$ in., the size of coil would be $2\frac{1}{2} \times 2 = 5$ in., less a slight amount by reason the sliver hanging down to the edge of the plate.

DRAWING FRAMES.

REFERENCES TO GEARING PLAN OF DRAW FRAME.

A Draft Wheel.	G Back Roller Wheel driving 2nd Roller.
B Inside Driving Pulley.	H Second Roller Wheel.
C Front Roller Pulley.	J Back Roller Wheel driving 3rd Roller.
D Front Roller Wheel.	K Third Roller Wheel.
E Crown Wheel.	
F Back Roller Wheel.	



GEARING OF DRAW FRAME

FIG. 65

DOBSON & BARLOW LTD

CALCULATIONS.

Draft between front and back rollers:—

$$\frac{E \times F \times \text{dia. of front roller.}}{D \times A \times \text{dia. of back roller.}}$$

To find the change wheel A.

(A in the above formula is the change wheel, so by substituting any given draft in place of A the result will give the change wheel required for that draft.)

$$\frac{E \times F \times \text{dia. of front roller.}}{D \times \text{draft} \times \text{dia. of back roller.}}$$

Draft between second and back rollers:—

$$\frac{G \times \text{dia. of 2nd roller.}}{H \times \text{dia. of back roller.}}$$

Draft between third and back rollers:—

$$\frac{J \times \text{dia. of 3rd roller.}}{K \times \text{dia. of back roller.}}$$

Draft between the front and second rollers:—

Total Draft.

Draft between second and back $\times$ draft between third and back.

Weight of Drawing = $\frac{\text{Number of ends} \times \text{weight of carding.}}{\text{Draft.}}$

Draft = $\frac{\text{Number of ends} \times \text{weight of carding.}}{\text{Weight of drawing.}}$

Change Pinion = $\frac{\text{required weight} \times \text{change pinion on}}{\text{present weight.}}$

Change Pinion = $\frac{\text{change pinion on} \times \text{present hank.}}{\text{Required hank.}}$

COMPARATIVE SPEEDS.

Intermediate pulley on driving shaft, 16in. dia. $\times$ 4in. wide.

Front roller pulley, driven by above pulley, 12in. dia. $\times$ 2in. wide.

Driving Shaft. Revs. per Min.	Front Roller, Revs. per Min.	Driving Shaft. Revs. per Min.	Front Roller, Revs. per Min.	Driving Shaft. Revs. per Min.	Front Roller, Revs. per Min.
150	200	205	273 $\frac{1}{3}$	260	346 $\frac{2}{3}$
155	206 $\frac{2}{3}$	210	280	265	353 $\frac{1}{3}$
160	213 $\frac{1}{3}$	215	286 $\frac{2}{3}$	270	360
165	220	220	293 $\frac{1}{3}$	275	366 $\frac{2}{3}$
170	226 $\frac{2}{3}$	225	300	280	373 $\frac{1}{3}$
175	233 $\frac{1}{3}$	230	306 $\frac{2}{3}$	285	380
180	240	235	313 $\frac{1}{3}$	290	386 $\frac{2}{3}$
185	246 $\frac{2}{3}$	240	320	295	393 $\frac{1}{3}$
190	253 $\frac{1}{3}$	245	326 $\frac{2}{3}$	300	400
195	260	250	333 $\frac{1}{3}$		
200	266 $\frac{2}{3}$	255	340		

SPEEDS.

The general rule for obtaining the speed of any shaft, wheel or pulley is as follows:—

Multiply all driving wheels and pulleys by the speed of the driving shaft for a dividend. Take as a divisor the product of all driven wheels and pulleys. The diameters of pulleys are to be taken, and the teeth in the wheels.

(1) Speed of slubbing frame main shaft or jack shaft = 325 per minute. A 55 wheel on this shaft drives through a carrier a 50 on end of spindle shaft. 56's spindle shaft bevels drive 28's spindle foot bevels. Find speed of spindles per minute.

$$\frac{325 \times 55 \times 56}{50 \times 28} = 715.$$

(2) Speed of jack shaft 325. Frame end pulleys 14in. diameter. Line shaft pulleys 20in. diameter. Find line shaft speed.

$$\frac{325 \times 14}{20} = 227.5.$$

In the second problem the rule is simply reversed. It may also be remarked that no matter how many wheels and pulleys are involved in a speed calculation, the same rule applies, and practically no reasoning is required. It is simply a question of arranging the terms into drivers and drivens.

In the second method of finding twist wheel for new frames hereafter given in this chapter, a calculation is given showing the manner of obtaining speed of frame shaft for a new frame, and forms the first part of the twist calculation. Numerous other examples of speed calculations are given in this chapter.

TWIST WHEEL; TWIST CONSTANTS; TWIST PER INCH.

A good rule for obtaining twist wheel in changing counts is as follows:—Multiply the square of the twist wheel on by the hank being made, and divide by the hank or counts required. The square root of the quotient will be the wheel required.

Example.—An intermediate frame is making a 1.25 hank with a 35 twist wheel on. Find twist wheel required for 1.75 hank intermediate.

$$(a) \quad 35 \times 35 = 1225.$$

$$(b) \quad \frac{1225 \times 1.25}{1.75} = 875.$$

$$(c) \quad \sqrt{875} = 29.58 \text{ twist wheel.}$$

A second rule is:—Find the square roots of the counts or hank roving the frame is making, and of the counts or hank it is desired to change to. Multiply the wheel on by

the square root of the hank being made, and divide by the square root of the hank desired.

A third rule is:—Multiply the wheel on by the hank being made, and divide by the hank required. Add the answer thus obtained to the wheel that was on, and divide by two.

Example.—Work the foregoing calculation by the rule last given.

$$(a) \quad \frac{1.25 \times 35}{1.75} = 25.$$

$$(b) \quad \begin{array}{r} 35 \\ 25 \\ \hline 2 \overline{)60} \\ 30 \end{array} \quad \text{Ans.}$$

This rule is useful for those who cannot work square root, or anyone in a hurry, but is not quite so accurate as either of the two preceding rules. The following rule is the best for obtaining twist per inch put into the roving at any of the bobbin and fly frames:—By the rule for speeds find the revolutions of spindles and of front roller to one of jack shaft or main shaft. From speed of front roller it is easy to find inches delivered to one revolution of jack shaft, and these inches being divided into the revolutions of the spindles the quotient will be the turns per inch.

Example.—In an intermediate frame let it be assumed that a 52 on main shaft drives through a carrier a 52 on end of spindle shaft. 60's spindle shaft bevels drive 30's spindle foot bevels. The revolutions of spindle will thus be:

$$\frac{1 \times 52 \times 60}{52 \times 30} = 2.$$

Again: A 30 twist wheel drives a 45 wheel on centre of top cone shaft. A 65 on end of top cone shaft drives a 130 on front roller. The revolutions of front roller will thus be:

$$\frac{1 \times 30 \times 65}{35 \times 130} = .428.$$

Assuming the front roller diameter to be 1.25 in., then inches delivered will be :

$$.428 \times 3.1416 = 1.3446,$$

and turns per inch

$$\frac{2.00000}{1.344} = 1.48 \text{ Ans.}$$

Those who are somewhat expert at these calculations will see that the above four calculations could all be reduced to one as follows :

$$\frac{1 \times 52 \times 60 \times 35 \times 130}{1 \times 52 \times 30 \times 30 \times 65 \times 3.1416 \times 1.25} = 1.48 \text{ about.}$$

Those carders or others who wish to obtain the constant for twist can do so by simply omitting the twist wheel from the preceding calculation :—

$$\frac{1 \times 52 \times 60 \times 35 \times 130}{1 \times 52 \times 30 \times 30 \times 65 \times 3.1416 \times 1.25} = 44 \text{ about.}$$

This rule is especially useful in starting a new frame for obtaining the twist wheel as indicated below. If the twist per inch, and the corresponding twist wheel are already known, a much easier method of finding constant is simply to multiply turns per inch by the twist wheel thus as above :—

$$1.48 \times 30 = 44.4 \text{ constant.}$$

The use of the constant for twist is to provide a ready means of ascertaining the twist per inch which any given twist wheel will give. For instance, with the foregoing constant, what twist will be put in by using a 25 twist wheel ?

$$\frac{44.4}{25} = 1.77 \text{ turns per inch.}$$

On the other hand, the constant divided by the amount of twist desired to be put in will give the required twist wheel. With above constant, what twist wheel must be put on to give 1.64 turns per inch ?

$$\frac{44.4}{1.64} = 27 \text{ twist wheel.}$$

As mentioned above, we can find constant as shown above, and then, in re-starting a frame under fresh conditions, or in starting a new frame, we can easily determine twist wheel required. The particulars required to obtain the constant are generally fixed quantities, which can easily be ascertained.

SECOND METHOD OCCASIONALLY USED.

In starting a new frame, or in re-arranging an old frame under entirely new conditions, the following method may be adopted for finding twist wheel, it being understood that any other terms could be substituted for those assumed here. Assume that you are intending to make a six-hank roving with a spindle speed of 1,000 revolutions per minute. A 50 on main shaft drives a 25 on end of spindle shaft, and 60's skew bevels drive 30's bobbin wheels.

(1) Find speed of main shaft as follows :—

$$\frac{1000 \times 30 \times 25}{60 \times 50} = 250$$

(2) The turns per inch for six-hank roving will be $\sqrt{6 \times 1.2} = 2.938$

(3) The inches delivered per minute by front roller will be :

$$\frac{1000}{2.938} = 339.$$

(4) Assuming diameter of front roller to be $1\frac{1}{8}$ in., the revolutions of front roller per minute will be :

$$\frac{339}{1.125 \times 3.1416} = 85.9.$$

(5) From the following particulars, in addition to those already obtained, it is now an easy matter to determine the twist wheel. A 126 on front roller is driven by a 63 on end of top cone. The twist wheel drives, by means of a carrier, a 55 on top cone shaft :

$$\frac{85.9 \times 126 \times 55}{250 \times 63} = 37.7 \text{ twist wheel.}$$

The second method is by no means as useful or as widely adopted as the former method.

A method often adopted by practical men in finding the turns per inch put into the roving is as follows:—Count the revolutions of spindles to one of the front roller, and divide this number by the circumference of front roller.

Example.—In an intermediate frame the front roller is 1.25 diameter, and the spindles make six revolutions to one of front roller. Find turns per inch.

$$\frac{6}{1.25 \times 3.1416} = 1.52;$$

or,

3.1416	
1.25	

157080	
62832	
31416	

3.927000	

3.927)6 00000(1.52
3927

20730
19635

10950

Often carders will simply say the spindles make 6 to front roller 1, or 7 or $7\frac{1}{2}$, or just as the case may be, without performing any calculation whatever.

RATCHET OR RACK WHEEL.

The rule for finding ratchet wheel in changing counts is as follows:—Multiply the square of the wheel on by the counts required, and divide by the counts spinning. Extract the square root of the quotient.

Example.—An intermediate frame is making a 1.25 hank with a 30 ratchet wheel on. Find wheel for 1.75 hank.

(a)

$$30 \times 30 = 900.$$

$$\frac{900 \times 1.75}{1.75} = 1260.$$

$$\sqrt{1260} = 35.5 \text{ ratchet wheel.}$$

The additional rules given for obtaining twist wheel apply equally as well to the ratchet wheel, except that the terms will have to be transposed. That is, the divisor for the twist wheel will be the multiplier for the ratchet wheel, and *vice versa*. A rule which is approximately correct only can be given for finding ratchet wheel in starting a new frame.

As we have previously remarked, many practical men seem to have only an imperfect understanding of the factors that govern or fix the correct size of the ratchet wheel. When starting a new frame it is a difficult matter to make a calculation that will give the correct wheel. This, however, is easier to do than in the case of a mule or ring frame, it being impracticable on the latter machines to lay down a rule for finding the builder wheel in starting a new machine that is even approximately satisfactory.

An approximately accurate rule can, however, be formulated to enable the size of the ratchet wheel to be found when a new fly frame is being started, although it involves a somewhat complex consideration. The number of layers of roving per inch increase of diameter of bobbin must first be ascertained. If this be multiplied by the diameter in inches of the full bobbin, it will give a total number of layers, which, of course, is equal to the total number of reversals or changes of the lifter in making the bobbins. The pitch of the teeth of the cone drum rack, the number of teeth in the wheel that drives it, the number of teeth in each of the bevels that drive the vertical shaft of the building motion, and the length of rack to be used being ascertained, will form the basis of a calculation for finding revolutions per set of bobbins that the ratchet wheel stud will make, and, consequently, the ratchet wheel itself. As the ratchet wheel moves one tooth for every double lift of the bobbins, the number of double lifts, divided by the revolutions of ratchet wheel, will give the teeth in the ratchet wheel. This rule, although only approximately correct, forms a basis to work upon in

starting a new frame. Its chief defect, perhaps, lies in the fact that so many conditions have to be laid down to begin with, some of which also are variable conditions.

For most practical men, the experimental method indicated below will probably be the best, either for new or old frames. Start the first layer that is put on the bobbins to have the ends winding at the required tension, effecting any desired slackening or tightening of the ends by changing the wheel on the end of the bottom cone drum, or else the wheel that gears into the sun wheel. The former wheel will affect both the speed of the lift and the rate of winding; while the latter, on some frames at any rate, will only affect the rate of winding. If, after the first layer has been wound on, the ends begin to work slack, put on a larger ratchet wheel; while, if on the other hand they are subject to an undue amount of tension, put on a smaller ratchet wheel. The cone belt must be in its correct initial position on the cone drums, and of the proper tightness. An observation should be made of the distance traversed by the cone belt during the building of a complete set of bobbins, which should be compared with the diameters of full and empty bobbins.

LIFTER WHEEL.

When changing counts the wheel on the end of the short shaft at the bottom of the gearing-frame end may either be changed, or, say the small strike wheel that drives the reversing bevels. In either case the wheel being a driver may be changed according to the following rule. Multiply the square of the wheel on by the hank roving now being made, and divide by the hank required. The square root of the quotient will be the answer.

Example.—You are making a 4-hank roving with a 22-strike bevel. Find bevel required to make an 8-hank roving.

$$(a) \quad 22 \times 22 = 484.$$

$$(b) \quad \frac{484 \times 4}{8} = 242.$$

$$(c) \quad \sqrt{242} = 15.55 \text{ Ans.}$$

Rules could be given for obtaining lifter wheel, bottom cone end wheel, jack wheel, and coning wheel, in starting a new frame, but as these would be of no practical benefit to anyone, perhaps, other than those connected with the making of frames, they are omitted. If they are changed at all by the carder or manager of the spinning mill it is done according to the reasoning given elsewhere in this chapter.

FLY FRAMES.

REFERENCES TO GEARING PLAN OF FLY FRAME, SHOWING MESSRS. DOBSON'S PATENT DIFFERENTIAL MOTION AND ITS CONNECTIONS, THIS FIRM KINDLY LENDING BLOCKS FOR 65, 66, &c.

A Draft Wheel.	P Skew Gear Wheel for Bobbins.
B Twist „	Q Bobbin Bevel Wheel.
C Star, or Ratchet Wheel.	R Jack Shaft Wheel.
D Lifter Wheel.	S Lifter Bevel Wheel on Jack Shaft.
E Jack Wheel.	T Upright Bevel on Lifter Shaft.
F Bottom Cone End Wheel.	U Strike, or Lifter Bevel Wheels.
G Driving Wheel for Bobbins.	V Top Cone Drum Wheel.
H Driving Wheel for Spindles.	W Top Cone Drum End Wheel.
I Back Roller Wheel.	X Large Front Roller wheel.
J Sun Wheel.	Y Small „ „ „
K Outside Spindle Wheel.	Z Top Carrier Wheel.
L Skew Gear Wheel for Spindles.	
M Spindle Bevel Wheel.	
N Outside Bobbin Wheel.	

CHANGE PLACES.

- A** Change for Draft. Wheels 35 to 60 teeth.
B „ Twist. „ 26 to 48 „
C „ Winding (Star Wheel). Wheels 10 to 50 teeth.
D Change for Traverse (Lifter Wheel) Wheels 16 to 26 teeth.
E Proportional to diameter of empty bobbin (Jack Wheel). Wheels 15 to 30 teeth.
F Traverse and diameter of bobbin (Cone Wheel). Wheels 14 to 30 teeth.

CALCULATIONS.

$$\text{Speed of front roller} = \frac{\text{Revs. of } B \times B \times W}{V \times X}$$

$$\text{Speed of spindles} = \frac{\text{Revs. of } H \times H \times L}{K \times M}$$

$$\text{Length delivered by front roller} =$$

$$\frac{\text{Revs. of } B \times B \times W \times \text{dia. of F.R.} \times 3.1416}{V \times X}$$

$$\text{Turns of spindle to one of front roller} = \frac{\text{Speed of spindles}}{\text{Speed of front roller}}$$

$$\text{Turns of spindle to one of front roller} = \frac{X \times V \times H \times L}{W \times B \times K \times W}$$

$$\text{Twist per inch} = \frac{\text{Speed of spindles}}{\text{Length delivered by front roller}}$$

$$\text{Twist per inch} = \frac{X \times V \times H \times L}{W \times B \times K \times M \times \text{dia. of F.R.} \times 3.1416}$$

$$\text{Twist Wheel B} =$$

$$\frac{X \times V \times H \times L}{W \times \text{twist per inch} \times K \times M \times \text{dia. of F.R.} \times 3.1416}$$

$$\text{Constant number for twist} =$$

$$\frac{X \times V \times H \times L}{W \times K \times M \times \text{dia. of F.R.} \times 3.1416}$$

$$\text{Twist Wheel} = \frac{\text{Constant number}}{\text{Twist per inch required}}$$

$$\text{Twist per inch} = \frac{\text{Constant number}}{\text{Twist wheel}}$$

$$\text{Total draft} = \frac{\text{Dia. of F.R.} \times \text{I} \times \text{Z}}{\text{Dia. of B.R.} \times \text{A} \times \text{Y}}$$

$$\text{Change Wheel A} = \frac{\text{Dia. of F.R.} \times \text{I} \times \text{Z}}{\text{Dia. of B.R.} \times \text{required draft} \times \text{Y}}$$

$$\text{Constant number for draft} = \frac{\text{Dia. of F.R.} \times \text{I} \times \text{Z}}{\text{Dia. of B.R.} \times \text{Y}}$$

$$\text{Change Wheel} = \frac{\text{Constant number}}{\text{Draft}}$$

$$\text{Hank roving} = \frac{7,000 \times \text{number of yards taken}}{840 \times \text{weight in grains}}$$

$$\text{Draft wheel when changing the hank} = \frac{\text{Present hank} \times \text{present change wheel}}{\text{Required hank}}$$

$$\text{Rack Wheel} = \sqrt{\frac{\text{Present rack wheel}^2 \times \text{required hank}}{\text{Present hank}}}$$

$$\text{Twist wheel B} = \sqrt{\frac{\text{Present twist wheel}^2 \times \text{present hank}}{\text{Required hank}}}$$

$$\text{Lifter wheel D} = \sqrt{\frac{\text{Present litter wheel}^2 \times \text{present hank}}{\text{Required hank}}}$$

$$\text{Star Wheel C} = \sqrt{\frac{\text{Present star wheel}^2 \times \text{present hank}}{\text{Required hank}}}$$

$$\text{Weight per yard of hank roving, in grains} = \frac{7,000}{840 \times \text{hank roving}}$$

$$\text{Time in minutes to build bobbin} = \frac{840 \times 36 \times \text{twist per inch} \times \text{hank} \times \text{weight of bobbin in oz.}}{\text{Revs. of spindles}}$$

$$\text{No. of sets in 10 hours} = \frac{600 \text{ minutes}}{\text{Minutes to build bobbin} + \text{time for doffing, \&c.}}$$

$$\text{Lbs. per day of 10 hours} = \text{Sets in 10 hours} \times \text{weight of bobbin}$$

$$\text{Hanks per day of 10 hours} = \text{Lbs. per day} \times \text{hank roving}$$

PRODUCTION OF A FLY FRAME.

Particulars of the production of bobbin and fly frames for different counts of roving, speed of spindle, &c., are given in matter accompanying Fig. 66. There are chiefly two practical methods of finding production of a fly frame by calculation.

(1) Count the revolutions of the front roller per minute. Multiply these revolutions by the diameter of the roller, by $3 \cdot 1416$ or by $\frac{22}{7}$ instead, by the number of minutes at work, and by the number of spindles in the frame. Divide by 12 in. = 1 ft.; 3 ft. = 1 yd.; 840 yds. = 1 hank, and by the hank roving to bring it to lbs.

Example.—The front roller of a roving frame is $1\frac{1}{8}$ in. diameter, and makes 130 revolutions per minute, and the frame is making a 5-hank roving. Find lbs. produced in $56\frac{1}{2}$ hours, allowing $5\frac{1}{2}$ hours for stoppages of all sorts, and the frame to contain 160 spindles.

$$\frac{9 \times 22 \times 130 \times 60 \times 51 \times 160}{8 \times 7 \times 12 \times 3 \times 840 \times 5} = 1480 \cdot 7 \text{ lbs.}$$

The second practical method of obtaining production is to take the hanks from the indicator when we know that it is correct.

Example.—If a roving frame is making a 5-hank roving, and registers on the indicator 40 hanks per week, and the frame contains 160 spindles, find lbs. produced per week.

$$\frac{40 \times 160}{5} = 1280 \text{ lbs.}$$

WRAPPING OF SLUBBINGS AND ROVINGS.

Suppose 15 yds. of slubbing weigh 5 dwts. 20 grs., what is the hank slubbing?

Rule.—Divide the weight reduced to grs. into 125 :—

$$24 \times 5 + 20 = 140 \text{ grs.}$$

$$\frac{140}{125 \cdot 00} = \cdot 89 \text{ hank slubbing.}$$

NOTE.—As is well known, the wrap reel for slubbing, rovings, and slivers, is one yard in circumference, as against $1\frac{1}{2}$ yards for yarn wrap reel.

Suppose 30 yds. of intermediate weigh 4 dwts. 20 grs., what is the hank intermediate?

Rule.—Divide the weight reduced to grs. into 250 :—

$$24 \times 4 + 20 = 116 \text{ grs.}$$

$$250 \div 116 = 2.15 \text{ hank intermediate.}$$

Suppose 60 yds. of roving weigh 3 dwts. 12 grs., what is the hank roving?

Rule.—Divide the weight reduced to grs. into 500 :—

$$24 \times 3 + 12 = 84.$$

$$500 \div 84 = 5.95 \text{ hank roving.}$$

These dividends are obtained as are nearly all dividends, *i.e.*, by a simple process of cancelling.

MISCELLANEOUS.

On a flyer-leading slubbing frame the diameter of full bobbin is $5\frac{1}{2}$ in., and diameter of empty bobbin is $1\frac{1}{2}$ in. The front roller delivers 450 in. of material per minute to each bobbin. Find the number of revolutions per minute which the bobbins must lose upon the speed of spindle to wind these 450 in. on both for full and empty bobbin :—

$$\text{Full bobbin} \quad \frac{450}{5.5 \times 3.1416} = 26.04.$$

$$\text{Empty bobbin} \quad \frac{450}{1.5 \times 3.1416} = 95.4.$$

In a bobbin-leading frame the bobbins would go the above revolutions faster than the spindles.

In a bobbin-leading frame the sun wheel in Holdsworth's motion makes 16 revolutions per minute at the commencement of the set of bobbins. The frame shaft makes 300 revolutions in the same time. Find revolutions of bush wheel or double-socket wheels?

$$300 \div 16 \times 2 = 37.5$$

It will be remembered that one revolution of the sun wheel always means that two revolutions are given to the socket wheel, in addition to those imparted directly by the frame shaft in a bobbin-leading frame. In a flyer-leading frame one revolution of sun wheel reduces speed of socket wheel by two revolutions.

INDICATORS.

WORM AND WORM WHEEL INDICATORS.

There are several types of indicators used on bobbin and fly frames, but in each case the front roller is the motor of the mechanism, and the construction and arrangement of the parts have to be such that the rapid revolution of the front roller can only give an exceedingly slow movement to the indicator face finger or face figures, as the case may be. In practical mechanics generally, the most common method of obtaining a very slowly revolving part from a quickly revolving shaft is by the employment of worms and worm wheels, as a single thread worm is only equal to a driving wheel having one tooth. Almost all frame indicators contain one or more worms and worm wheels. One type that has been largely employed contains no principle whatever other than this one, and with this type we will deal first.

One hundred hanks should be shown by the indicator when one hundred hanks have passed through the front roller to each spindle. Suppose the front roller be $1\frac{1}{8}$ in diameter, and a single worm on front roller drives an 85 worm wheel. On same stud is a second worm driving a second worm wheel containing 100 teeth. On same stud as the last wheel is a third worm driving a third worm wheel of 100 teeth. On same axis as the last wheel is placed the indicator face finger. When this finger has

gone once round one hundred hanks have been registered. Prove whether these wheels are so correct as to register exactly one hundred hanks when exactly that length has passed through the front roller to each spindle. If there be any difference, say how much, and whether it be for or against the tenter:—

$$\frac{100 \times 100 \times 85 \times 9 \times 22}{12 \times 3 \times 840 \times 8 \times 7} = 99.38$$

hanks passed through whilst one hundred hanks are being registered. This is .62 hanks in favour of the tenter. The reason for the above rule is, that by multiplying all the worm wheels together, we get revolutions of front roller to one of the indicator finger. The other terms are necessary to get the hanks delivered to the above-mentioned revolutions of front roller.

If we changed one of the wheels from 100 to 101 we should obtain

$$\frac{100 \times 101 \times 85 \times 9 \times 22}{12 \times 3 \times 840 \times 8 \times 7} = 100.37$$

or only .37 hanks discrepancy, but is against the tenter instead of being in her favour. These calculations, however, do not take note of $1\frac{1}{4}\%$ which is allowed for breakage.

If the diameter of the roller be more than $1\frac{1}{8}$ in., then the size of some of the wheels must be reduced so that the total product of the wheels shall be less than with $1\frac{1}{4}$ in. diameter. For instance, in a slubbing frame with $1\frac{1}{4}$ in. diameter of front roller we might have the following wheels:—

$$99 \times 101 \times 77$$

which would give

$$\frac{99 \times 101 \times 77 \times 5 \times 22}{12 \times 3 \times 840 \times 4 \times 7} = 100.02$$

or only .02 against tenter.

If a 100 wheel were put in place of the 101 we should get

$$\frac{100 \cdot 02 \times 100}{101} = 99 \cdot 03$$

or $\cdot 97$ in favour of the tenter. It will be noticed that $\frac{2 \cdot 2}{7}$ is used by us instead of $3 \cdot 1416$ for getting circumference of front roller.

In taking the indicators on a pair of frames at crossing-off time, suppose one shows at 98, and the previous week it was 64; the other shows at $24\frac{1}{2}$, and the previous week it was 90. The tenter is paid $3\frac{1}{4}$ d. per hank, find her week's wage.

1st frame has done $98 - 64 = 34$ hanks.

2nd " " $124\frac{1}{2} - 90 = 34\frac{1}{2}$ "

Total ... 68.5 "

68.5

3.25

3425

1370

2055

12)222.625

18.552 = say, 18s. $6\frac{1}{2}$ d.

We have 30 roving frames making a 9-hank roving, and each frame containing 160 spindles. Find the lbs. produced in a week if the frame indicators have registered as follows, and granting that the indicators are correct:

1st frame, 30 hanks.

16th frame, 29 hanks.

2nd " $30\frac{1}{2}$ "

17th " 30 "

3rd " $29\frac{1}{2}$ "

18th " 30 "

4th " 27 "

19th " $27\frac{1}{2}$ "

5th " 28 "

20th " $27\frac{1}{2}$ "

6th " 28 "

21st " $28\frac{1}{2}$ "

7th " 29 "

22nd " $28\frac{1}{2}$ "

8th " 29 "

23rd " $29\frac{1}{2}$ "

9th frame 31 hanks.			24th frame 29½ hanks.		
10th	„	31	„	25th	„ 28
11th	„	27½	„	26th	„ 28
12th	„	27½	„	27th	„ 30
13th	„	28	„	28th	„ 30
14th	„	28½	„	29th	„ 30½
15th	„	28½	„	30th	„ 30½
433			437		

The average is therefore—

$$\frac{433 + 437}{30} = 29 \text{ hanks per spindle.}$$

$$\therefore \frac{29 \times 160 \times 30}{9} = 15466\cdot6 \text{ lbs for the week.}$$

In some cases there are four worms and four worm wheels. In such a case, suppose the wheels are 51, 17, 20, 50, and the diameter of the front roller is 1½ inch. Prove the indicator as before.

$$\frac{51 \times 17 \times 20 \times 50 \times 9 \times 22}{12 \times 3 \times 840 \times 8 \times 7} = 101\cdot2$$

which is 1·2 against the tenter, as she is only paid for 100 hanks. This equals, however, the 1¼ per cent. which would be allowed for breakage. Suppose the frame produces 35 hanks per spindle, and the tenter is paid 3d. per hank, then the tenter's wage should be—

$$\frac{35 \times 2 \times 3}{12} = 17\text{s. } 6\text{d.}$$

However, at 100 hanks she suffers a loss of 1·2 hanks, which, for 70 hanks, will be equal to—

$$\frac{1\cdot2 \times 70}{100} = \cdot84 \text{ hanks,}$$

and this means a loss in money per week of—

$$\cdot84 \times 3 = 2\cdot52\text{d.}$$

If a mill contained 30 tenters, and each tenter loses 2·52d. per week, it would be a total profit to the firm per week of—

$$2.52 \times 30 = 6s. 3\frac{1}{2}d.,$$

and in a year of 52 weeks would equal—

$$2.52 \times 30 \times 52 = \text{£}16 \text{ 7s. 6d.}$$

The discrepancy could be reduced by changing the 51 wheel, as given above, for a 50, which would give—

$$\frac{50 \times 17 \times 20 \times 50 \times 9 \times 22}{12 \times 3 \times 840 \times 8 \times 7} = 99.38 \text{ hanks,}$$

or .62 hanks in favour of the tenter. As this is only half the discrepancy of the above, it might be adopted, although it would give the firm a total loss of over $\text{£}8$. The allowance, $1\frac{1}{4}$ per cent. for breakage, rectifies the matter.

Another style of frame indicator has a worm on the front roller, driving a worm wheel. On the same stud as this worm wheel is a second worm, which gears simultaneously into two worm wheels. On the face of one of these wheels are the figures to show the hanks from one up to a hundred, and on the axis of the other worm wheel is the indicator finger. Both finger and face are thus revolved in the same direction, but the finger travels faster than the face, and by the difference in speed the hanks are registered. This is on the principle of both bobbin and flyer revolving in the same direction, and winding being accomplished by one going faster than the other. The author has had some personal experience with this kind of indicator, and is by no means favourable to it. Very few of them are now at work, and it is deemed inadvisable to occupy space with calculations relating to this style.

The following wheels were taken from another old style of indicator, diameter of front roller $1\frac{1}{4}$ in. A single worm on front roller gave motion to a 50-worm wheel. Then there were four small pinions, each containing six teeth, giving motion to three wheels containing 60 teeth each, and one containing 100 teeth. These worked out as follows, far too much being allowed for breakage in this indicator:—

$$\frac{50 \times 60 \times 60 \times 60 \times 100 \times 5 \times 22}{1 \times 6 \times 6 \times 6 \times 6 \times 4 \times 7 \times 12 \times 3 \times 840} = 108.26.$$

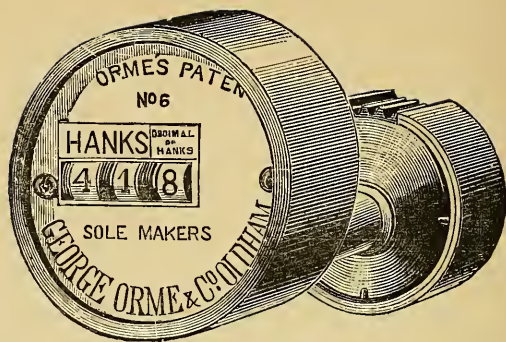


FIG. 67.

ORME'S INDICATOR.

Fig. 67 shows the indicator for frames as made by Messrs. George Orme & Co., Atlas Meter Works, Oldham. It is a popular indicator, and gives very satisfactory results. In each of the indicators previously mentioned the dial plate or clock face is divided into 100 divisions, each representing one hank. As the hanks produced per week may vary anywhere between about 30 to about 46 or so, according to the class of work being made, it will be seen that it usually takes from $2\frac{1}{4}$ to $3\frac{1}{2}$ weeks for the pointer or finger to make one complete revolution. It is quite impracticable to observe any movement of the finger, and the divisions are so fine that the state of the indicator at crossing-off time is often taken one or two hanks wrong, causing dissatisfaction between the tenters and the management. In Messrs. Orme's indicator the tenth part of a hank is clearly and prominently exhibited.

The principle of its action and construction is somewhat curious, and may be gathered from Figs. 68 and 69, and from the following description. As is usual with frame indicators, the instrument is driven from the front roller by means of a worm and a worm wheel. Secured to the same

stud as this worm wheel is a second worm **A** driving a second worm wheel **B**. These wheels are the only variable factors in the mechanism, and have to be changed according to the diameter of the front roller. For various diameters the wheels are as per the following table:—

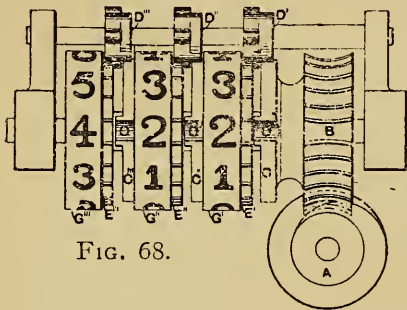


FIG. 68.

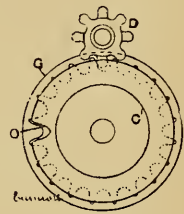


FIG 69.

			1st Wheel.		2nd Wheel.
Front Roller	1"	...	39	...	25
"	$1\frac{1}{4}$	...	39	...	20
"	$1\frac{3}{16}$	...	39	...	21

The wheel **B** is in one piece, with the disc **C¹** connected to the third dial, the remaining discs **C²** and **C³** being connected to the second and third dial cylinders respectively, and all running loose on the shaft or stud. **E¹**, **E²**, **E³** are three wheels each connected to their respective dial cylinders **G¹**, **G²**, **G³**. **D¹**, **D²**, **D³** are three smaller wheels running loose on the stood, and engaging with and driving the larger wheels as shown. Fig. 64 is a side view of the wheels **E¹**, **D¹**, and the disc **C¹**, which will help materially in explaining the manner of working. If we can understand the action of these parts we comprehend the whole secret of the motion. It can be seen that the disc **C¹** has a gap in its circumference, and its action is somewhat similar to the Geneva stop used in

some watches and clocks to prevent overwinding. At the same point is also a small projection to the left so that practically C^1 is equal to a wheel having one tooth, like a single worm. D^2 has eight teeth, but four of them, or every alternate tooth, are only half the width of the wheel, the remaining four being the full width. From this construction it follows that the wheel D^1 is always locked, and cannot possibly turn round, except when the indentation O , in the disc C^1 , is at the top. When this indentation does arrive at the top, the little projection on the inside of the disc takes hold of a short tooth of the small wheel D^1 , and moves the latter wheel round a quarter of a turn, the long tooth in the interval fitting into the gap in the disc. As soon as the gap has passed the top, the wheel D^1 is locked again, and cannot be turned until the disc completes another revolution, when the same process is repeated, so that the disc D^1 performs a quarter of a revolution, or is moved two teeth for every revolution of the disc, and whenever it is not being turned by the disc it is securely locked. The wheel E^1 has 20 teeth, and gears with D^1 , and, consequently, it is moved two teeth, or a tenth of a revolution, for every revolution of C^1 . The dial cylinder C^1 is marked with the figures 0 to 9 , and the result of the mechanism is that the figure on this dial is moved one forward for every revolution of C^1 or the wheel B .

In exactly the same manner the motion is carried forward to the other discs and dial cylinders. After leaving the first two worms and worm wheels, the action of the parts is exactly as if there were three more worms and three worm wheels, each containing ten teeth. When the dial cylinder (or the one nearest the worm wheel B) has made one revolution, a hank of rove has passed through the front roller, ten hanks have passed through for a revolution of the second dial, and 100 hanks for a complete revolution of the third dial cylinder. This is

plus a little for breakage. The most useful thing about the indicator is the ease with which readings can be accurately made. The first dial gives decimals of a hank, the second units, and the third tens, and, therefore, the reading of the indicator shown, Fig. 68, will be 42.2 hanks. The proof of the indicators is given below for 1 in., $1\frac{1}{4}$ in., and $1\frac{3}{16}$ in. front roller diameters, allowing $1\frac{1}{4}\%$ for breakage:—

1 in. DIAMETER.

$$\frac{3 \cdot 1416 \times 39 \times 25 \times 1000}{12 \times 3 \times 840} = 101.29 \text{ hanks.}$$

$1\frac{1}{4}$ in. DIAMETER.

$$\frac{3 \cdot 1416 \times 39 \times 20 \times 5 \times 1000}{12 \times 3 \times 840 \times 4} = 101.29 \text{ hanks.}$$

$1\frac{3}{16}$ in. DIAMETER.

$$\frac{3 \cdot 1416 \times 39 \times 21 \times 19 \times 1000}{12 \times 3 \times 840 \times 16} = 101.08 \text{ hanks.}$$

TO FIND TRAVERSE OF CONE RACK.

The ratchet wheel contains 25 teeth, and there are 100 layers put on the bobbin. On same stud as the ratchet wheel is a 30 bevel driving a 26 bevel on upright shaft. Also on the upright is a 30 rack pinion driving the cone rack, which is $\frac{3}{8}$ ths inch pitch. Find length traversed by cone rack and cone belt during the set of bobbins.

$$\frac{100 \times 30 \times 30 \times 3}{2 \times 25 \times 26 \times 8} = 26.87 \text{ inches.}$$

The sum could be worked in three parts. (a) Find revolutions of ratchet wheel and stud. (b) Find revolutions of upright. (c) From last answer find inches traversed.

TO FIND LAYERS PUT ON BOBBIN.

Assuming all particulars to be same as in preceding problem, excepting that the full 30 inches of cone rack be

traversed and the number of layers be unknown, find the latter.

$$\frac{30 \times 2 \times 25 \times 26 \times 8}{30 \times 30 \times 3} = 115.5 \text{ layers.}$$

TO FIND DIAMETER OF ONE PLY OF ROVE.

Assuming diameter of empty bobbin to be $1\frac{1}{4}$ inches, and of full bobbin to be $3\frac{3}{4}$ inches, and, as found above, 115.55 layers to be put on the bobbin, find the approximate diameter of one ply.

$$(a) \quad 115.5 \text{ layers} = 115 \times 2 = 231 \text{ plies.}$$

$$(b) \quad 3.75 - 1.25 = 2.5 \text{ inches diameter of roving.}$$

$$(c) \quad \frac{2.5000}{231} = .0108 \text{ inches diameter of one ply.}$$

TO FIND TRAVERSE OF ROUND RACK.

The ratchet wheel contains 25 teeth, and there are 100 layers put on the bobbins. On same stud as ratchet wheel is a 16 pinion driving the round rack, which is $\frac{1}{4}$ in. pitch. Find inches traversed by round rack or hanger bar during the set.

$$\frac{100 \times 16 \times 1}{2 \times 25 \times 4} = 8 \text{ inches.}$$

TO FIND ROUND RACK WHEEL.

Assuming all the particulars to be as in previous question, but the rack wheel unknown, it may be found as follows:—

$$\frac{2 \times 25 \times 4 \times 8}{100 \times 1} = 16.$$

TO FIND RATCHET WHEEL.

Assuming all the particulars to be as in previous question, but ratchet wheel unknown, it may be found as follows:—

$$\frac{100 \times 16}{2 \times 4 \times 8} = 25.$$

DRAFT OR DRAG BETWEEN ROLLERS AND BOBBINS.

The following method may be adopted to find whether there be any draft between bobbins and rollers, *i.e.*, whether the winding power be greater than the amount of roving delivered from the rollers. The particulars are taken from the lecture diagrams Figs. 19 and 20, and the speed of the driving shaft is assumed to be 350 per minute, and the diameter of front roller 1in., and the twist wheel 50. The inches delivered per minute will be as follows:

$$\frac{350 \times 50 \times 60 \times 3.1416}{50 \times 120} = 549.78 \text{ inches.}$$

The inches of winding power per minute will be as given below, assuming that 12 % is lost by slippage of cone belt; diameter of top cone be 7"; diameter of bottom cone be 3.5; bottom cone end wheel 20; and diameter of empty bobbin $1\frac{3}{8}$.

$$\frac{350 \times 50 \times 7 \times 88 \times 20 \times 16 \times 2 \times 65 \times 50 \times 10 \times 22}{50 \times 3.5 \times 100 \times 84 \times 100 \times 42 \times 24 \times 8 \times 7} =$$

594.45 inches of winding power.

As only 549.78 inches of rove are delivered in the same time, this would give an excess of 44.67 inches, or so much draft between the rollers and the bobbins. As this would not give good results, we might reduce the size of the bottom cone end wheel. When the bobbins have begun to be filled, it will depend upon the ratchet wheel whether there be any draft between the rollers and the bobbins. Attention must also be directed to the remarks made elsewhere in this treatise upon adjusting the winding.

TO FIND INCHES TRAVERSED BY LIFTER RACK PER MINUTE.

Assuming the lower cone to make 500 revolutions per minute for the empty bobbin, and all the wheels from lower cone to lifter vertical racks to be as given in Figs. 19 and 20, taking the racks at $\frac{3}{8}$ in. pitch, cone end wheel at 20, and copy wheel at 25, find inches traversed by the lifter per minute:—

$$\frac{500 \times 20 \times 16 \times 26 \times 25 \times 13 \times 33 \times 22 \times 15 \times 3}{84 \times 20 \times 40 \times 76 \times 52 \times 52 \times 80 \times 8} = 4.997 \text{ inches.}$$

If the lifter change wheel had been left out of above calculation, and in its place the inches of lifter traverse required had been put, the requisite change wheel could have been found.

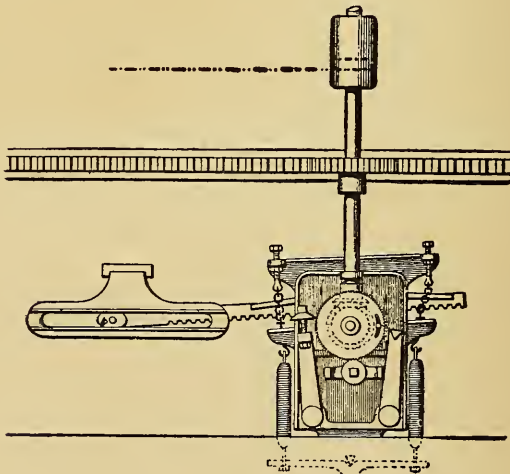


FIG. 70.

PATENT RATCHET WHEEL.

Figs. 70 to 73 inclusive are intended to convey an idea of an ingenious method of dispensing with the necessity for changing ratchet wheels, patented by an eminent firm of machinists. The idea in its broadest sense has often presented itself to makers and users of cotton spinning and weaving machinery. Without any doubt whatever, if some simple, general, and effective method of dispensing with the necessity for change wheels could be devised, it would make the fortune of the inventor. The patent ratchet wheel under discussion is a special application of this general idea, and another special application may be

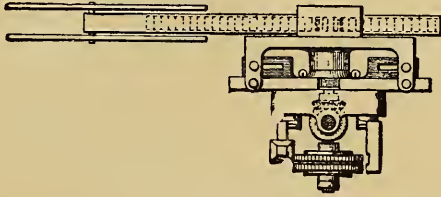


FIG. 71.

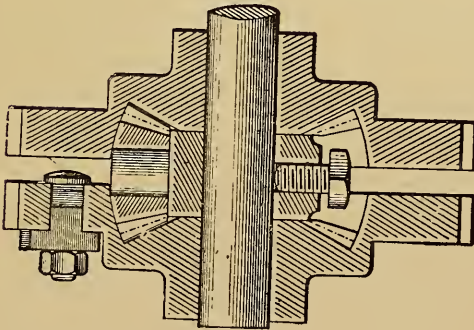


FIG. 72.

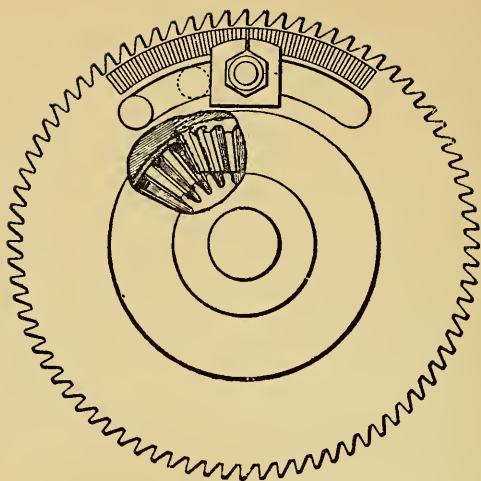


FIG. 73.

found on some slasher sizing frames, in connection with the marking motion for determining the length of "cut" to be made.

It will be seen from the drawings that there are two ratchet wheels instead of only one, and both are loosely mounted on the proper shaft, and both are equal in teeth and diameter. Each differs from the usual construction in that it has teeth on its inner face, and a small bevel wheel, as shown, engages simultaneously with both sets of teeth.

The usual drag weight for moving the long rack tends to turn this small bevel round, and therefore the two ratchet wheels. As one only of these wheels is set free from its detent lever at a given time, only this one wheel can move, and this it does after the same principle as the loose bevel of a yarn wrap-reel. Each ratchet wheel has one detent lever only. In one of them is a slot with an adjustable stop-piece, while in the other is a stud fitting

into the slot. When the building motion changes at the end of the lift, one of the ratchet wheels is set free and makes a slight movement governed by this slot and stud. The manner in which this arrangement works is as follows:—Suppose the frame is being put on a coarser roving, the adjustable stop-piece can be moved so as to allow of every change of the ratchet wheel to be of greater extent. This adjustment is greatly facilitated by the application to the motion of a pointer and a numbered index or indicator, which enables any required size of alteration to be readily made.

TWIST PER INCH.

As on the mule, the twist per inch for fly-frames varies with the kind of cotton employed. The square root of the counts should always be taken in determining the proper twist per inch. On the roving this may be multiplied by 1.4 for poor American cotton or Indian, 1.2 for good American or moderate Egyptian, while 1.1 may be taken for good Egyptian or Sea Islands. On the intermediate frame, the thickness of the cotton will allow us to have rather less twist—say the square root of the counts $\times 1.20$ for poor American or Indian, 1.15 for good American, and .80 for good Egyptian.

On the slubber the loose nature of the cotton demands slightly more twist than on the intermediate, though not as much as the roving frame—say the square root of the counts $\times 1.25$ for Indian and poor American, by 1 for good American and poor Egyptian, and .8 for better cottons. When a roving has been passed through the hole in the flyer top, and through the small hole in the side of the flyer, it should be passed partially round the flyer top to the left hand, and not to the right, in an ordinary twist way frame, otherwise it will not allow the twists to enter the roving properly. That is, revolving twist way as is the usual method. On a weft way frame the roving would require to be wrapped round the flyer top to the right.

INDEX.

A

	PAGE.
Abegg Roving Frame	13
Action of Cradles	118
Adjustment of Lever Weights...	3
Ailments of Fly Frame	189
Altering Change Pinions	294
Anchor Bar Disarranged	157
Arrangement of Gearing	26

B

Balance Weights	62
Balancing of Lifter	191
„ „ Flyers	210
Beaded Bobbins	139
Belt on Cone Drums... ..	82
Belts, Tension of Cone	103
Bottom Cradle of Change Motion	119
Bobbin and Fly Frames	53
Bobbin v. Flyer Lead	69
Bobbin and Flyer Leading	60
Bobbins Running Off at Ends...	158
Bottom Cone End Wheel... ..	160
Bottom Rail Fitting	204
Box of Tricks	66
Break Draft	265
Bronze Collars	216
Building Motion	116
Building Motion Spring	157
Bush for Bobbin Leading... ..	72

C

	PAGE.
Calculation on—	
„ Brooks & Doxey's Differen-	
tial Motion	226
„ Changing Counts... ..	115
„ Coiler Motion	349
„ Coils in One Revol. of Cam	350
„ Cone Drums	89
„ Cones	102, 94, 97
„ Curtis & Rhode's Motion	247
„ Dobson & Barlow's Motion	254
„ Doubling	24
„ Drafts	268
„ Drawing Out	25
„ Equalising Slivers	20
„ Hanger Bar	131, 136
„ Hank Slivers	347
„ Hank Slivers	347
„ Howard & Bullough's Motion	232
„ Indicators for Fly Frames ...	349
„ Lifter	132
„ Lifter Wheel	340
„ Orme's Indicator... ..	355
„ Production „ „	349
„ Ratchet Wheel	338, 356
„ Ratchet Wheel for New	
Frames	339
„ Tapering Rod	131, 136
„ Tension of Rovings	318
„ To Find Diameters of Roving	356

	PAGE.
Driving of Draw-frame Parts ...	28
Driving of Drawing Frames ...	49
Duplex Driving	65, 106
Dyer's Patent Tube Frame ...	5

DIFFERENTIAL MOTIONS.

New	218
------------	-----

BROOKS & DOXEY'S.

Action of Parts	224
Calculations on	226
Details of	221
For Flyer Leading	228
Middle of Bobbins	225
Re-action of Bobbins... ..	227
When Bobbins are Full	225
When Starting Empty Bobbins .	224

CURTIS & RHODES'S.

Action of Parts When Making	
Bobbins	244
Arithmetical Demonstration of..	247
Description of Parts	241
Reprint of Article on... ..	245
When Running Ends Slack for	
Doffing	242
When Starting New Set of	
Bobbins	243

DOBSON & BARLOW'S.

Action of Parts for Empty	
Bobbins	251
Action of Parts for Full Bobbins	252
Action of Parts When Making	
Bobbins	252
Additional Remarks	253
Arithmetical Demonstration ...	254
Descriptions of Parts... ..	249

HOWARD & BULLOUGH'S.

	PAGE.
Action of Parts for Doffing ...	231
Arithmetical Demonstration ...	238
Article on	236
Calculations on	232
Description of Parts	230
For Full Bobbins	235
When Starting Empty Bobbins .	233

E

Eclipse Frame	13
Electric Stop Motion	32
Elementary Description of Fly	
Frames	55
Empty Bobbins of Various Sizes	105
Ends of Slubbing Flying Loose	72
Epicyclic Strain of Wheels ...	80
Equality of Top and Bottom	
Tapers... ..	137
Erection of Draw Frame	36
Erection of Fly Frames	195
Evan Leigh's Theory	169
Extras on Fly Frames	187

F

Fast Pulley of Draw Frame ...	40
Fibres, Parallelisation of	16
Fly Wheel	57
Flyer to Bobbin Lead	171
Flyer v. Bobbin Lead	6
Flyer, Set-on of... ..	140
Flyers Fitting on Spindles	65
Frame Ends	196
Frames, Can	3, 12
" Abegg	13
" Skeleton	4
" Stretching	6
" Jack	4
" Tube	5
" Fly	6
" Eclipse	13

	PAGE.
Frames. Drawing	14
Fluting of Rollers	296
Full Bobbin Stop Motions ...	63

G

Gauges and Sizes of Frame	
Parts	187
Gauges Used for Spring Pieces..	201

H

High Speed of Wheels for Bobbin	
Leading	70
Holdsworth's Jack-i'-th'-Box ...	74
Hooks, Chains &c.	149

I

Improvements in Frames	334
Increasing Number of Draw	
Frames	24
Indicators	174, 62
Intermediate Drafts	270
Introduction to Building Motion	116
Introduction to Fly Frames ...	53
Iron Rollers of Draw Frames ...	39

J

Jack Frame, Old	4
Jack-i'-th'-Box	74, 4, 59
Jack Screws	137, 139
„ „ Length of	143
Jack Shaft Fitting	202
Jack Wheel... ..	114

L

Laps, Regulation of	307
Lead, Flyer v. Bobbin	6
Leather Rollers... ..	273, 60
Leather Roller Setting	215
Lecture at Ashton	99
Lecture at Ashton	306

	PAGE.
Levelling-up of Fly Frames ...	197
Lever Weighting of Rollers ...	3
Lift, To Regulate Length of ...	127
„ Calculation on	132
„ How Shortened	129
Lifter, Balancing of	191
Lifter Easing Motion	342
Lifter, Loading of	151
Lifter Rail	62
Lifter Shaft... ..	153
Lifter Shafts	212
Lifter Train of Wheels	61
Lifter Weights Touching Floor.	161
Lifter Wheel	159, 112
Lining-up of Fly Frames	195
Loose Boss Rollers	274
Loss of Cotton	294

M

Mangle Wheel	9
Material, Progress of... ..	15
Mechanism of Building Motion.	117
Mendoza Pulley... ..	6
Metallic Drawing Pollers... ..	47
Method of Obtaining Cone Out-	
lines	97
Motions, Draw-frame Stop	29, 32
Mule Ends Breaking... ..	289

N

Narrow Cone Belts Best	105
Necessary Gearing	207
Non-horizontal Tapering Rod... ..	140

O

Objects of Drawing Frames ...	16
Oiling and Cleaning... ..	188

P

Parallel Additions to Cones ...	109
Parallelisation of the Fibres ...	16

	PAGE.
Patent Stop-motion for Draw	
Piecing of Rovings, Bad...	288
Planet Motion, Sun and ...	10
Position of Cone Belt ...	300
Positions of Cradles ..	143
Practical Remarks on Cone	
Drums...	103
Practical Test ...	336
Prices for Fitting ...	215
Principle of Winding on Fly	
Frames ...	67
Preparation Frames, Old...	3
Preparation of Cone Drums ...	93
Presser Attachment ...	335, 327, 65
Presser Finger Wrapped Differ-	
ently ...	335
Pressers, Right and Left Hand .	172
Production of Draw Frames ...	52
Production of Fly Frames ...	180
Progress of Material ...	15
Frame...	31

R

Rack for Cone Belt ...	66
Rack Motion Fixing ...	198
Rack Unequal ...	7
Rack Unequal ...	86
Rack Weight ...	163
Railway Draw Frame ...	11
Ratchet Wheel ...	113
Ratchet Wheel Catch Slipping...	155
Ratchet Wheel Alterations	269, 299
Re-action of Parts on Cone Belt	78
Reaching Lever on Draw Frames	41
Re-action on Hanger-bar ..	66
Recurring Decimals ..	96
Repairing of Bobbins and Fly	
Frames ...	209
Repairing of Draw Frames ...	39
Results of Cradle Movements...	122
Reversing Bevels Shaft ...	213
Reversing Rod Spiral Spring ...	163

	PAGE.
Right and Left-hand Pressers ...	172
Robert s Quadrant ...	53
,, Heads ...	12
Roller Driving on Old Frames ..	1
,, Beams ,, ,, ...	1
,, Beam ...	63
,, Beam Position ...	195
,, Diameters and Distances	
	261, 263
,, Driving of ...	26
,, Iron ...	59
,, Setting ...	2
,, Traverse ...	64
,, ,, Spring of ...	156
,, Weighting ...	2
Royton, Lecture at ...	73
Running Over and Under of	
Bobbins ...	158

S

Set-on of Flyer ...	140
Setting of Cam Motion ...	38
Setting of Rollers ...	2
Setting of Roller Stands ...	214
,, Rollers ...	256
Seventy Years Ago. Draw	
and Fly Frames...	1
Shape of Cone Drums ...	83
Shell Rollers v. Solid ...	275
Single Boss Rollers ...	276
Single and Thick Roving...	285, 291
Single Preventor Rollers ...	45
Skeleton Frame...	4
Skew Bevels, Right and Left	
Hand ...	344
Skew Gear Shafts ...	212
Slackening and Tightening of	
Ends ...	179
Slide Double ...	133
Slippage of Cone Belt ...	71
Slippage of Cone Belt ...	151
Slubbing Spindle Bad ...	310

	PAGE.
Solid Rollers	274
Speeds of Fly Frame Parts ...	353
Spewing of Rollers	296
Spindle Diameters	54
Spindle Footstep Lubricator ...	175
Spindle Top	211
Spindle Wheels	57
Spindles, Disposition of	187
Spindles, Lining up	206
" Numbers of	55
Spoons on Draw Frame	40
Spongy Roving	86
Springs of Frames	64
Spring of Ratchet Wheel	156
Spring Pieces	199
Springs v. Weights	146
Stop Motions	29
Strain on Roving for Flyer	
Leading	74
Stretching Frame	6
Strike Small Wheel	159 61
Students, Great Improvement in	70
Summary of Change Motion	
Action	116
Summary of Frame Ailments ...	189
Sun and Planet Motion	10
Sun Wheel Action	78
Swing, Compensating	176
" Gearing of	57
Swing Telescope	162

T

Tapering of Bobbin to Make	
Equal	137
Tapering Rod	131, 132
" Comparative Length	
of	134
Tapering Rod not Horizontal ...	140
Telescope Swing	162
Tenters, Wind Cone Belts about	104
Theory of Cone Belt Slippage...	84

	PAGE.
Theory of Concave and Convex	
Shape	95
" Equal Diminutions in	
Speed	87
" Parallel Cones	17
" " " Action	18
" " Doubling	19
" Spongy Roving	86
" Unequal Rack	86
Timing of Rollers	319
Total Doublings	23
Traverse Motion for Rollers	280, 277
Traverse for Rollers	64
Tube Frame	5
Twist in Fibres	322
Twist per inch	170
Twist Way to West Way	176
Twist Wheel	112
Twist Wheel	320, 59
Two Beam System	2

U

Unequal Rack	7
Uneven Roving	293
Uniform Cones	88

V

Variable Traverse Motion ...	280
Variation in Slivers	20
" " Sun Wheel Speed ..	81
Various Items	9
Various Sizes of Empty Bobbins	105
Vertical Lifter Racks	305

W

Warps, Light	295
Waste in Flyer Leading	70
West Frames	333
West to Twist	345
Weighting of Rollers	2, 3, 51
Weights Balance	62

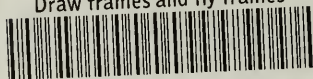
	PAGE.		PAGE.
Weights <i>v.</i> Springs for Cradle...	146	Winding Problems and Connec-	
„ of Lifter Touching		tions	67
„ Floor... ..	160	Wrapping of Cotton on Bobbins	69
„ of Top Rollers	277	Wrapping of Rovings	292



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